



# GLOBAL A.I. DEVELOPMENTS

HEALTHCARE SECTOR

April'24

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## Introduction

This report explores the contemporary landscape of AI and Generative AI technologies, examining their applications within the healthcare industry. The objective is to reveal the transformative impact of these technologies, elucidating the specific areas where AI is making significant strides. Geographically, AI development is a global phenomenon, with specific regions standing out as leaders in revenue generation, especially within the healthcare sector. Pioneering companies in innovation play a crucial role in influencing the trajectory of AI within the industry. The report underscores the dynamic and multifaceted influence of AI on businesses and their workforce, encompassing aspects from operational streamlining to predictive capabilities and security assurance.

This paper explores the implications and fast view of the AI sector, offering a brief overview. It explores how artificial intelligence is going to transform the industry and influence processes, supplier relationships, job roles, employment numbers, and skill requirements. It also emphasizes the expected benefits for customers, emphasizing how AI would enable better services and more individualized interactions. In order to provide a fair assessment of the possible advantages and difficulties in this ever-changing environment, the analysis also takes into account the inherent risks connected with the deployment of AI.

The paper recommends AI as a tool to enhance experience rather than replace it for senior workers. The dynamic of human-machine collaboration is shown to represent a huge opportunity.

The study concludes by highlighting the dynamic and complex effects of AI on business and stressing the necessity of strategic planning and a cooperative approach for effective integration.

01



## The AI market size per industry sector

The global market for artificial intelligence in healthcare, valued at \$15.4 billion in 2022, is predicted to grow at a rate of 37.5% annually from 2023 to 2030.

The main reasons behind this growth include the increasing availability of digital patient health data, a rising demand for personalized medicine, and the need to lower healthcare expenses. Factors like a growing global elderly population, changes in lifestyles, and an increase in chronic diseases are contributing to a higher demand for early disease detection and understanding. Artificial Intelligence (AI) and machine learning (ML) algorithms play a key role in predicting diseases early by analyzing past health data.

Advanced technologies such as deep learning, predictive analytics, content analytics, and Natural Language Processing (NLP) are helping healthcare professionals identify underlying health conditions at earlier stages. The Covid-19 pandemic has accelerated the adoption of AI technologies in healthcare, especially in the rapid diagnosis and detection of different virus strains. AI/ML algorithms have been used to diagnose Covid-19 positive patients based on chest CT images, symptoms, and exposure history, addressing the shortage of healthcare workers.

Supportive government initiatives, increased mergers and acquisitions, technological collaborations, and the ongoing pandemic have significantly boosted the growth of AI in the healthcare market. According to a study, AI-based algorithms accurately detected 68% of COVID-19 positive cases, demonstrating the effectiveness of these technologies. AI/ML technologies are widely implemented in various healthcare functions, such as diagnostics, patient management, medication management, claims management, workflow management, machine integration, and cybersecurity, leading to substantial growth in the sector. (Grand View Research, 2023)

# 02



## What is driving this

The main drivers behind this growth, as mentioned, are the increasing availability of digital patient health data like medical histories, test results, treatment plans, which are all stored electronically, rising demand for personalized medicine, and the need to lower healthcare expenses.

Other factors to consider are a higher demand for early disease detection and understanding a growing global elderly population, changes in lifestyles, and an increase in chronic diseases.

Healthcare professionals are able to detect underlying medical disorders early on thanks to advanced technologies including natural language processing (NLP), deep learning, predictive analytics, and content analytics. (Precedence Research, 2023) (Grand View Research, 2023) (Binarks, 2023)

### Driving factors:

**Improved Diagnostic Capabilities:** This technology, like machine learning and natural language processing, are being leveraged to analyze complex medical data, including imaging and genetic information, leading to more accurate diagnosis. For instance, AI-powered diagnostic tools have demonstrated the ability to detect diseases like cancer and diabetic retinopathy with a high degree of accuracy, driving more investments and pilot testing in this field. Google is now testing its AI as an assistant with Mayo Clinic researchers. (Politico, 2023)

**Operational Efficiency:** AI is expected to improve performance and operational efficiency in healthcare. It can help in areas like operating room optimization, early identification of patient deterioration, and adverse-event detection, leading to improved clinical operations. Predictive analytics and AI-driven insights can help healthcare organizations optimize staff schedules, manage inventory, and forecast patient admissions, thereby enhancing operational efficiency. (AHA, n.d.)

**Cost Reduction:** Insurers and providers expect significant, sustainable cost reductions from applying AI to administrative tasks and personalized care. AI has the potential to reduce costs while improving the quality and safety of healthcare delivery. (Cornejo, 2018)

**Staffing Shortages:** Persistent and growing staffing shortages in healthcare can be addressed by equipping healthcare workers with the data and intelligence required to provide better care. AI can assist in various tasks, thereby alleviating some of the burden on healthcare professionals.

It is predicted that in 2024, AI will come to the rescue, equipping healthcare workers with the data and intelligence required to provide even better care. Imagine community health workers (CHWs) and family caregivers armed with AI copilots that assist them in delivering in-home care. These AI assistants will provide suggestions on topics to discuss and offer insights required by the medical team. (Healthcare Dive, 2023)

**Comprehensive Disease Management and Patient Care:** AI can help clinicians take a more comprehensive approach to disease management, better coordinate care plans, and assist patients in better managing their long-term conditions. This can lead to improved patient outcomes and better compliance with care plans (PWC, n.d. )

# 03



## What are the barriers to its adoption

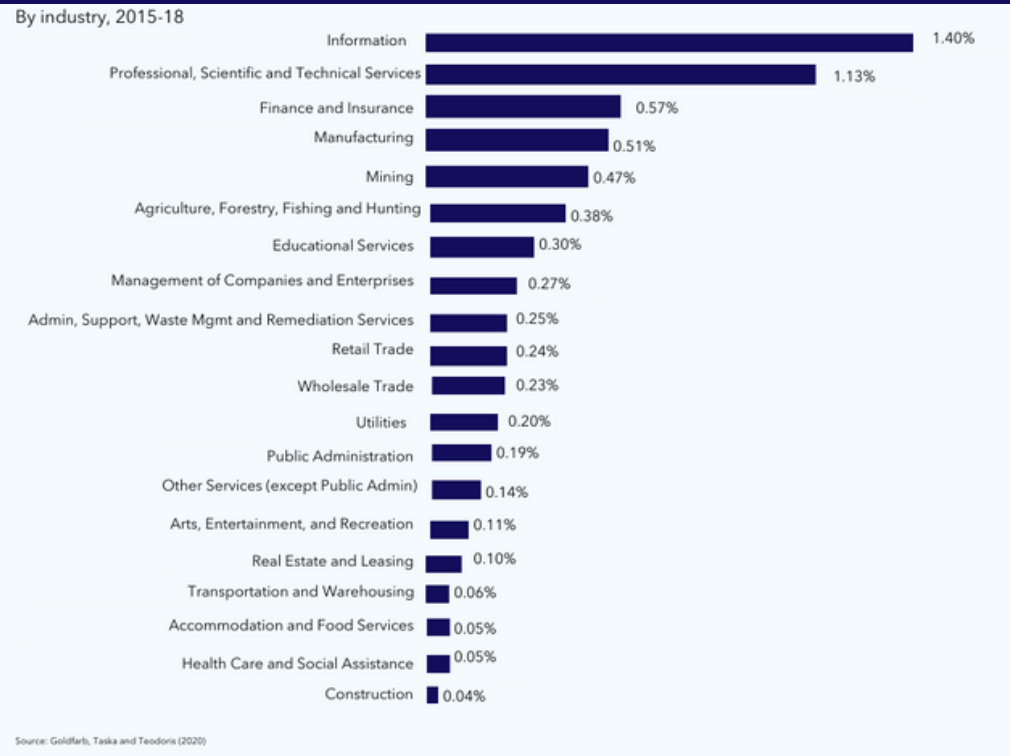
The barriers to the adoption of AI in healthcare include algorithmic limitations, data access limitations, regulatory barriers, misaligned incentives, regulations, patient and provider trust, privacy concerns, and the lack of established AI suppliers.

Algorithmic and data access restrictions can hinder efficient AI application in healthcare. Furthermore, issues like patient and provider trust, privacy concerns, and a lack of established AI providers can restrict AI's mainstream adoption in the healthcare sector.

Although there is a potential for AI in healthcare, the adoption of this technology in this sector is also due to job advertisements that require AI related skills.

Even for relatively skilled job postings in hospitals, like doctors, nurses, medical technicians, research lab workers, and managers, just about one in every 1,250 required AI capabilities. This is lower than in other industries including professional, scientific, or technical services, banking and insurance, and education, etc. (Goldfarb and Teodoridis, 2022)

## SHARE OF U.S. JOB POSTINGS REQUIRING AI-RELATED SKILLS



### Complementary innovations:

Another barrier for its adoption is that much of the research emphasizes the role of complementary innovations in the adoption of AI and other information technology by companies. For instance, in the implementation of other software or implementations like the internet or electronic medical records, they required other changes and innovations in changing their processes, contracts etc. These adoptions come with a price, so it is easier for larger companies to adopt and implement them, so AI will be first adopted by the larger size companies rather than smaller size companies.

### Algorithmic limitations:

Advancements in neural networks have expanded the capabilities of AI but have raised concerns about interpretability. Neural networks are challenging to comprehend the rationale behind specific predictions. Without proactive scrutiny, AI algorithms generated by neural networks may possess undiscovered flaws, as seen in instances of "algorithmic bias." This lack of transparency undermines trust in AI, posing a significant risk, particularly in healthcare, where professionals may be held accountable for AI-informed decisions. Recognizing the need for trustworthy AI, there is a widespread acknowledgement of the importance of complementary innovations, such as technologies or processes that enhance the interpretability of AI algorithms. Various large-scale initiatives are dedicated to promoting trustworthy AI. Interpretable AI, which addresses the black box problem, could enhance trust by enabling healthcare workers to grasp how AI arrives at specific recommendations. Additionally, initiatives are underway to establish clinical trial standards for AI systems, further fostering the adoption of AI in healthcare by providing insights into the likelihood of biased or incomplete recommendations (Goldfarb and Teodoridis, 2022).



## **Regulatory barriers:**

Additionally, regulatory barriers present the most direct policy implications. Addressing these barriers requires innovation in the approval process, ensuring a clear pathway for device makers and software developers to commercialize their products. Additionally, innovative solutions are needed to facilitate data sharing without compromising patient privacy. Establishing clear rules regarding liability in case of issues could increase the adoption of AI. If AI adoption is deemed beneficial for improving healthcare productivity, reducing these regulatory barriers becomes crucial (Goldfarb and Teodoridis, 2022).

Policy implications related to challenges in data collection and distrust in algorithms primarily involve sustained funding for research rather than introducing new regulations. Governments and nonprofits are already allocating substantial research funds, especially in addressing concerns related to trust. Concerning misaligned incentives, achieving complementary innovation in management processes through policy interventions is challenging. Antitrust policies to ensure healthy competition could be beneficial, as competition has proven to enhance management quality. However, aside from these measures, there are limited policy tools available to alter these incentives (Goldfarb and Teodoridis, 2022).

In summary, AI adoption in healthcare has been relatively slow compared to other industries, but Policymakers can contribute to fostering adoption through innovative approaches related to privacy and regulatory approval pathways. Nevertheless, tools such as clarifying rules, funding research, and promoting competition may prove to be the most effective means to drive meaningful AI adoption in healthcare (Goldfarb and Teodoridis, 2022).

# 04



## Where AI is developing

### Areas within the sector:

With a multitude of advantages, AI is quickly progressing in a number of healthcare domains. Here are a few major areas where AI is advancing significantly:

1. **Clinical Decision Support Systems:** AI is being used to develop systems that can analyze complex medical data to assist healthcare professionals in making accurate diagnoses and treatment plans.
2. **Diagnosis and Treatment Recommendations:** AI algorithms are being employed to interpret medical images, such as X-rays and MRIs (Magnetic Resonance Imaging), to aid in the early and precise detection of diseases.
3. **Patient Engagement and Adherence:** AI-powered tools are being utilized to personalize patient care, improve medication adherence, and enhance patient engagement through virtual health assistants and remote monitoring devices.
4. **Administrative Activities:** AI is streamlining administrative tasks, such as billing, scheduling, and managing electronic health records, to improve efficiency and reduce healthcare costs.
5. **Healthcare Research:** AI is accelerating medical research by analyzing large datasets to identify potential drug candidates, predict disease outbreaks, and uncover new insights into complex diseases.
6. **Robotics and Surgery:** AI-enabled robotics are being increasingly used to assist surgeons in performing complex procedures with precision and minimal invasiveness.
7. **Preventive Health and Risk Assessment:** AI is showing significant promise in preventive health and risk assessment, with applications emerging to prevent and predict chronic diseases and other illnesses (Avalere, 2019).

## AREAS WITHIN THE SECTOR



These developments in AI have the potential to lead to more personalized, efficient, and effective care, ultimately improving patient outcomes and the overall healthcare experience (IBM Education, 2023)(Davenport, T., & Kalakota, R.,2019).

### Key companies:

These are some of the world's top companies in the IA industry in the healthcare sector:

- **DeepMind (US)** is Google's division, is well-known for its radiological solutions for the identification of eye diseases, breast cancer screening tools, and other products.
- **Augmedix (US)** is a medical documentation expert. They created an AI-powered method to take text notes from doctor-patient talks, extract data from them, and then enter it into the Electronic Health Record (EHR).
- **CloudMedX Health (US)** to provide doctors with innovative methods for treating diseases and insights into a patient's health, they analyze data from clinical notes and electronic medical records (EMRs) using natural language processing (NLP) and deep learning.
- **Corti (Denmark)** is an AI-powered assistant. With the use of voice analysis and cross-referencing it with the patient's medical history, it may recognize a heart attack and alert medical personnel.
- **Butterfly Network (US)** has created a portable ultrasound imaging device. It integrates cloud, artificial intelligence, and semiconductors in a pocket-sized device using Ultrasound-on-Chip technology.
- **Enlitic (US)** is a medical company that analyzes massive volumes of medical photos and other data to find new insights using deep learning.
- **Arterys (US)** an AI-driven method for analyzing radiologic images has been developed by them. Additionally, it is FDA-approved and cloud-based.
- **Caption Health (US)** employs their ultrasound interpreting technology to focus on early disease identification. This AI-powered diagnostic gadget enables any doctor to look at any portion of the body.
- **Behold.ai (UK)** assists radiologists in analyzing radiological pictures with AI. They developed an algorithm that has 90% accuracy in identifying abnormalities in a variety of medical scans and photos. (Binariks, 2023)

## Geographically, where is AI development taking place:

These are some of the companies that are using AI to make noteworthy advancements in the healthcare sector by region:

### North America

- IBM (United States): a front-runner in the healthcare AI space, this business provides AI solutions for a range of healthcare applications, such as drug discovery, medical imaging, and patient care (MarketsandMarkets, 2023).
- AWS (United States): Healthcare firms can avail AI services and solutions from Amazon Web Services, a cloud computing platform (MarketsandMarkets, 2023).
- Flatiron Health (United States): a provider of healthcare technology that leverages AI and data analytics and precision medicine to enhance cancer care (MarketsandMarkets, 2023).
- Google Health (United States): a provider of medical technology that leverages AI to enhance patient outcomes in the areas of medication development, medical imaging, and patient care (MarketsandMarkets, 2023).

### Europe

- Siemens Healthineers (Germany): a multinational provider of medical technology solutions, including AI-powered patient management, diagnostics, and imaging (MarketsandMarkets, 2023).
- AstraZeneca (United Kingdom): a pharmaceutical business that prioritizes biotechnology drug discovery and research and development, including AI-powered precision medicine (Binariks, 2023).
- DeepMind (United Kingdom): a British artificial intelligence business that creates AI-based healthcare solutions, including disease diagnosis and treatment planning (MarketsandMarkets, 2023).

### Asia-Pacific

- Netgear (China): a Chinese business that specializes in artificial intelligence (AI) solutions for healthcare, encompassing patient care, diagnostics, and medical imaging (MarketsandMarkets, 2023).
- NVIDIA (China): a tech firm that offers deep learning and artificial intelligence technologies for use in drug development, medical imaging, and patient care (MarketsandMarkets, 2023).
- Alibaba Health Information Technology (China): a business that enhances medical imaging and diagnostics with AI (Nasdaq, 2017).

### South America

- Dr. Consulta (Brazil): an AI-powered medical consultation and health management services provider for the healthcare industry (IDB Invest, n.a.).
- Hi Technologies (Brazil): An organization that employs AI to enhance patient care and medical diagnostics (Tech emerge, n.a.).

### Middle East and Africa

- Niramai Health Analytix (India): An organization that enhances breast cancer diagnosis and screening with AI (Google Cloud, n.a.).
- Vezeeta (Egypt): A healthcare technology firm operating in the Middle East and Africa that offers AI-powered medical consultations and health management services (Egypt Today, 2021).

Table 1. Company A.I development areas

Company	Country	Medical imaging	Drug Discovery	Patient care/management	Cloud computing platform	Data analytics	Precision medicine	Diagnostics	Medical consultations	Screening	Treatment planning
IBM	US	•	•	•							
Google Health	US	•	•	•							
NVIDIA	China	•	•	•							
Siemens Healthineers	Germany	•		•				•			
Netgear	China	•		•				•			
Alibaba Health Information Technology	China	•						•			
Google DeepMind	UK							•			•
AstraZeneca	UK		•				•				
Dr. Consulta	Brazil								•		
Hi Technologies	Brazil								•		
Niramai Health Analytix	India								•	•	
Vezeeta	Egypt								•		
AWS	US				•	•					
Flatiron Health	US					•	•				

\*This table only shows some of the main services and solutions these companies offer. For more detailed information, please click on the company name to visit their website.

### Top regions in terms of revenue:

The North American market has the biggest revenue share in the globe, accounting for 57.7% of global revenue, according to a Grand View Research analysis. Numerous variables, including the development of healthcare IT infrastructure, the increase in healthcare expenses, the widespread use of AI/ML technologies, the encouragement of government initiatives, the attraction of financing opportunities, and the presence of significant industry players, can be attributed to this dominance. The growing senior population, changing lifestyles, rising chronic illness rates, desire for value-based care, and higher awareness of AI-based technology deployment are all factors that have contributed to the market's robust rise in North America.

Europe is the second-largest area in the AI healthcare market, thanks to strong contributions from key players in the life sciences sector like Germany, the UK, France, Spain, Ireland, Switzerland, and Belgium. Both research and development (R&D) and drug discovery initiatives in biotechnology are underway in these countries.

Asia Pacific is the market with the quickest growth. The higher growth is linked to both the rapid advancement of IT infrastructure and the entrepreneurship focused on AI-based solutions. The surge in funding from private investors, venture capitalists, and non-profit organizations is propelling the adoption of these technologies with the objectives of lowering costs, enhancing data security and analysis, and increasing therapeutic outcomes. Government initiatives that make it easier for healthcare providers and businesses to embrace AI-based technology are among the major factors propelling the growth of the Asia Pacific market.

## AI IN HEALTHCARE MARKET



Source: Grand View Research, 2022

05



# AI sector implications

## Quick view

### Positives and Negatives of AI Development in the Healthcare Sector

The use of Artificial Intelligence (AI) in healthcare is changing things. It has good things it can do, but there are also some problems and important things to think about. As technology gets better, AI is becoming a strong tool in healthcare. It can change how we diagnose and treat illnesses, and even how we do administrative tasks. But, while it can help in taking care of patients and making things work better, there are also big challenges and ethical questions that we need to be really careful about.

Table 2. Positives and negatives of AI developments continuing

Positives	Negatives
<p><b>1. Medical Image Enhancement:</b> Generates synthetic images for training systems.</p>	<p><b>1. Data Privacy Concerns:</b> Risks associated with synthetic patient data.</p>
<p><b>2. Drug Discovery Acceleration:</b> Assists in identifying effective compounds.</p>	<p><b>2. Reliability Issues:</b> Potential for inaccurate predictions or diagnoses.</p>
<p><b>3. EHR Augmentation:</b> Enhances EHRs with detailed clinical notes.</p>	<p><b>3. Regulatory Challenges:</b> Difficulty aligning with healthcare regulations.</p>
<p><b>4. NLP in Medical Reports:</b> Summarizes and generates narrative for easy understanding.</p>	<p><b>4. Implementation Costs:</b> High initial costs for system integration.</p>

Table 2. Positives and negatives of AI developments continuing

Positives	Negatives
<p><b>5. Personalized Treatment Plans:</b> Analyzes patient data for tailored recommendations.</p>	<p><b>5. Resistance to Technology:</b> Healthcare professionals resistance to AI adoption.</p>
<p><b>6. Healthcare Chatbots:</b> Provides quick responses and enhances patient engagement.</p>	<p><b>6. Ethical Concerns:</b> Raises ethical dilemmas related to AI-driven decisions.</p>
<p><b>7. Medical Literature Generation:</b> Generates summaries based on existing literature.</p>	<p><b>7. Limited Generalization:</b> Challenges in generalizing Ai models across populations.</p>
<p><b>8. Radiology Report Automation:</b> Automates the generation of radiology reports.</p>	<p><b>8. Lack of Human Touch:</b> Reduced human interaction in healthcare.</p>
<p><b>9. Disease Prediction:</b> Predicts disease risk based on patient data.</p>	<p><b>9. Data Security Risks:</b> Vulnerability to cyber threats and data hacking.</p>
<p><b>10. Telemedicine Support:</b> Creates conversational agents medical training.</p>	<p><b>10. Complex Integration Process:</b> Challenges in integration with existing systems.</p>
<p><b>11. Medical simulation:</b> Creates simulations for safe medical training.</p>	<p><b>11. Dependency on Data Quality:</b> Reliance on high-quality datasets for accuracy.</p>
<p><b>12. Drug Formulation Optimization:</b> Assists in optimizing drug formulations.</p>	<p><b>12. Job Displacement Concerns:</b> Potential job displacement due to automation.</p>



## How is AI expected to change the industry

The healthcare industry is realizing the benefits AI can bring, and it is now being used in different areas across the entire value chain. Additionally, its use in the healthcare space is expected to continue to increase in the next five years.

Generative AI holds significant importance in healthcare, showcasing its ability to create data, images, text, and predictions through different key applications:

- **Medical Image Generation:** Various generative models, like GANs (Generative Adversarial Network), produce synthetic medical images, aiding in enhancing and training medical imaging systems such as CT scans, MRI, and X-rays. It proves valuable when real patient data is limited.
- **Drug Discovery and Molecular Design:** Generative AI plays a role in identifying effective compounds for drug discovery, expediting the process of finding new drug candidates and optimizing their properties. AI-driven models hasten the design of new compounds by simulating and forecasting chemical interactions while reducing expensive trial and error. This game-changing technology not only speeds up the drug development process but also has the potential to open up novel treatments for diseases that were previously incurable. This will usher in a new era of precision medicine and have a substantial impact on the outcomes of healthcare around the world.
- **Electronic Health Record (EHR) Augmentation:** Generative AI enhances EHRs by generating detailed and contextually relevant clinical notes, reducing the administrative burden on healthcare professionals, and improving the completeness and accuracy of patient records.
- **NLP in Medical Reports:** With medical data, generative AI can summarize and generate narratives, making it easier for doctors to understand complex information and automate report generation.
- **Personalized Treatment Plans:** Generative AI analyzes patient data, including medical history, details, and lifestyle, to provide personalized treatment plans and recommendations. Consolidating patient information through AI in healthcare is a transformative development. AI-driven systems have the capacity to efficiently gather and centralize diverse patient data, including medical histories, diagnostic results, treatment plans, and even real-time monitoring data. By seamlessly integrating and organizing this wealth of information, healthcare providers can access comprehensive patient profiles in real time, enabling more informed and timely decision-making.
- **Healthcare Chatbots:** Generative AI is utilized in chatbots for quick responses to patient queries, generating appointment reminders, and managing medication schedules, enhancing patient engagement with 24/7 support.
- **Medical Literature Generation:** AI assists researchers by generating summaries, abstracts, or entire papers based on existing literature, facilitating knowledge dissemination and staying updated with medical advancements.
- **Radiology Report Generation:** Generative models automate the generation of radiology reports from medical images, reducing turnaround time and streamlining the reporting process.
- **Disease Prediction and Risk Assessment:** Analyzing patient data, medical history, and test results, generative AI predicts disease risks and produces warning signs for proactive healthcare interventions.
- **Telemedicine and Virtual Consultations:** Generative AI supports telemedicine by creating conversational agents that assist in symptom diagnosis, provide preliminary advice, and collect patient information before virtual consultations.
- **Medical Simulation:** In medical training, generative models create simulations of surgical procedures or patient interactions, offering a safe environment for medical students to practice and enhance their skills.
- **Drug Formulation and Dosage Optimization:** Considering factors like drug interactions and patient-specific requirements, generative AI aids pharmaceutical companies in optimizing drug formulation and dosages.

- **Improving Diagnoses and Prognoses:** Healthcare is being transformed by artificial intelligence (AI), which improves both diagnostics and prognoses. AI can quickly and effectively diagnose diseases through the processing of enormous amounts of medical data, frequently at an earlier stage when interventions are most beneficial. It provides professionals with intelligent decision support, assisting in choosing treatments and managing medications. Additionally, AI-driven risk assessment systems use patient data to forecast illness susceptibility, enabling customized preventive measures. AI has the potential to change healthcare into a more patient-centered, precise, and proactive system as it develops, which will ultimately improve outcomes and lower costs.
- **Fraud Prevention:** AI-based fraud detection in the healthcare industry has emerged as a crucial instrument for preserving the reliability of healthcare systems. AI algorithms can examine enormous numbers of claims and transaction data to look for anomalies and possible cases of fraud due to the complexity of healthcare billing and insurance systems. These AI algorithms are able to spot odd trends in physician conduct, patient information, and billing, raising suspicion in cases
- **Providing Social Care for Patients:** Some hospitals have even started using AI in patient care. While these systems may not be ready to automate operations yet, they can provide social care to improve patient mental health. This has immense potential of further improving workforce productivity, operational efficiency, mitigating risk, and enhancing patient experience. In fact, within the next three years, 75% of healthcare institutions expect to be using AI in some form. (Journal of mHealth, 2022) (Emizentech, 2023)

## **How will it affect how jobs are done, skills needed, number of people employed, procedures, impact on suppliers**

### **Meaning for the People in the Sector**

If the growing trend of using AI in healthcare continues, it will become a crucial part of future digital health systems. This has a big impact on medicine and healthcare, making them better for everyone involved. Good healthcare is important for a thriving society, and using AI to analyze data in a more efficient way is really important. This can make a big difference, even saving lives and making patient care better. As we saw during the recent COVID-19 pandemic, AI can also help a lot during global health crises.

The people who work in the healthcare industry will be significantly impacted by the use of AI. A paper from McKinsey and the European Union's EIT Health claims that AI has the potential to enhance healthcare professionals' daily lives by enabling them to spend more time caring for patients, which can boost employee morale and increase retention (Spatharou, Hieronimus, Jenkins, 2020). Furthermore, by enhancing healthcare practitioners' knowledge, AI can assist in making crucial decisions in the clinical setting, improving patient outcomes (AHA, n.d.). Moreover, AI can improve clinical, operational, and financial outcomes and change the way that work is done in hospitals and health systems of any size or location (AHA, n.d.). By increasing the productivity and efficiency of care delivery, the use of AI in healthcare is also creating new jobs and possibilities for professionals in the field, such as data analysts and AI specialists, who can help solve the predicted shortage of healthcare workers (Spatharou, Hieronimus, Jenkins, 2020) (Davenport, & Kalakota, 2019). But the application of AI also brings up concerns about possible hazards, ethical dilemmas, and the need for ongoing monitoring and careful regulation to minimize unfavorable effects. These concerns also relate to the influence that AI may have on patients, healthcare providers, and health systems (Spatharou, Hieronimus, Jenkins, 2020) (Davenport, & Kalakota, 2019). In summary, the application of AI in healthcare presents opportunities as well as problems for those working in the field, requiring them to pick up new skills, adjust to new technologies, and understand the moral and practical ramifications of AI in healthcare.

## 1. How it will affect jobs

AI has a lot of potential in healthcare, and as it keeps getting better, it can change how we treat complex medical conditions. This is great for medical professionals like doctors and pathologists, pushing the boundaries of medical science. AI can make medical processes smoother, especially in healthcare systems that have a lot of work. But we also need to think about the fact that using AI might mean some jobs in healthcare could be done by machines instead of people.

Using AI in medicine can also help reduce mistakes in making clinical decisions. However, we have to remember that AI, even though it's really good, is not perfect. It might not completely get rid of mistakes, especially when dealing with a lot of data. In situations where there's a ton of data, there's still a chance of mistakes and missing information, which can be a big deal, especially in important areas like prescribing medication. Even though AI has a lot of potential, it reminds us that we still need humans to watch over things and make sure patients are safe and healthcare keeps improving.

The adoption of these new technologies is probably going to cause a change in the kinds of occupations that are in demand, with a focus increasingly on positions requiring the creation and administration of artificial intelligence AI systems (Lovegrove, 2023). Though AI can streamline administrative work and increase diagnostic accuracy, there are worries that roles that can be automated by AI algorithms may be replaced. Because of their lack of training or abilities, certain workers may be left behind in this situation (Lovegrove, 2023). On the other hand, some experts argue that incorporating AI might lead to new employment prospects (Lovegrove, 2023). The impact on employment will go beyond simple increases or decreases; instead, the nature of labor itself will change, offering an opportunity to refocus on improving and perfecting patient care (Spatharou, Hieronimus, & Jenkins, 2020). Since the effects of automation and AI on healthcare occupations are probably going to be unevenly spread across different types of professions, it is critical to support workers appropriately (Moulds, Horton, 2023)(Spatharou, Hieronimus, & Jenkins, 2020).

Contrary to popular opinion, AI is actually positioned to augment human talents rather than to entirely replace them. This means giving medical practitioners access to advanced medical information analysis, automating time-consuming tasks, and enhancing diagnostic capabilities through the use of AI. AI has a lot to offer healthcare workers, freeing up more time for them to focus on patient care and human-centered decision-making (Rajaratnam, 2023).

## 2. How it will affect skills needed

The development of AI in healthcare is expected to affect the skills needed in the healthcare workforce. As AI is deployed in healthcare, it will require significant changes in the composition, competencies, and skill sets of the healthcare workforce (American Hospital Association, 2023).

The integration of AI into clinical workflows and electronic health record (EHR) systems will necessitate parallel action from practitioners, organizations, and systems, all working together to embed digital and AI skills within healthcare (McKinsey and Company, 2020).

The healthcare jobs most likely to be automated would be those that involve radiology and pathology, rather than those with direct patient contact. However, even in jobs like radiologist and pathologist, the penetration of AI into these fields is likely to be slow (Future Healthc J. 2019).

AI is more likely to complement existing roles than replace them, and HIT professionals will be vital resources helping organizations harness the power of AI. New categories of jobs that didn't exist ten years ago are expected to emerge, and HIT professionals will be required to guide AI to its highest and best use (Healthcare IT leaders, 2023).

The development of AI in healthcare will require healthcare professionals to acquire new skills and competencies to work alongside AI systems effectively.

The following are some significant ways that AI will impact the abilities required in the healthcare sector:

- **Technical Skills:** To successfully apply AI in fields like decision support, imaging applications, and operational management, healthcare personnel would need to acquire technical skills like data analysis, programming, and software development (AHA, n.d.)(Saboo, Chenna, n.d.).
- **AI Knowledge and Familiarity:** Healthcare professionals will need to be knowledgeable with AI technologies including computer vision, machine learning, and natural language processing (AHA, n.d.)(Rajaratnam, 2023).
- **Patient Privacy and Data Security:** Given the sensitive nature of healthcare data and the growing application of AI in the field, a thorough grasp of patient privacy and data security standards will be essential (Rajaratnam, 2023).
- **Adaptability and Continuous Learning:** For best results, healthcare workers will need to be flexible and willing to learn new techniques for incorporating AI into current systems (Brown, Wadhera, Saboo, n.d.).
- **Managerial Roles and AI Adoption:** In order to provide accurate and helpful patient care, healthcare managers and professionals will need to modify their jobs and become "AI whisperers" by integrating AI into current systems (Rajaratnam, 2023).
- **Collaboration with AI:** Healthcare workers will have to be ready to work with AI in order to automate tedious jobs, decipher complicated medical data, and improve diagnostic abilities (Rajaratnam, 2023).

### 3. How it will affect number of people employed

The integration of AI in healthcare is expected to have a significant impact on the workforce, reconfiguring responsibilities, and redefining the contours of various roles. While automation and AI will affect the number of jobs in healthcare, the demand for occupations is set to increase, even allowing for the fact that approximately 10 percent of nursing activities could be freed up by AI. AI has the potential to revolutionize healthcare by improving care, productivity, and efficiency in health systems, and delivering better health outcomes for patients.

Some of the key impacts of AI in healthcare on employment include:

- **Job displacement and creation:** AI might displace some jobs, but it will also create new ones. For example, the role of a radiologist could be changed rather than replaced by AI. Radiologists can focus on interpreting more complex cases and building partnerships with other departments, while AI takes care of routine tasks.
- **Redefining roles:** AI will redefine the responsibilities of various healthcare professionals. For instance, the role of a medical assistant could be altered by AI, as it is expected to see a decline of -43% in employment growth.
- **Increased productivity:** Productivity is expected to rise by 36% in general, with the assistance of more unskilled labor and automation.
- **Job satisfaction:** The impact of new technologies will be felt differently across different healthcare occupations, and it is important to support staff accordingly. Automation and AI in healthcare will enable staff to switch their time and attention to more complex tasks, such as patient care, which can lead to higher job satisfaction.
- **Workforce optimization:** AI applications in healthcare can help organizations manage their workforce more effectively. For example, AI can be used to predict physician burnout and identify at-risk physicians, allowing organizations to take proactive steps to address the issue.

While AI in healthcare will undoubtedly bring about changes in the workforce, it will also create new opportunities and roles, and ultimately improve the quality of care for patients. By understanding these impacts and addressing the challenges and opportunities that come with AI in healthcare, the industry can be better prepared to navigate the ongoing evolution of AI in the sector.

#### 4. How it will affect healthcare procedures

The application of AI in healthcare is poised to bring about significant benefits across various aspects of medical procedures and patient care. One of the key advantages is the early detection and diagnosis of diseases. Machine learning models can analyze a patient's symptoms and data from medical devices to identify potential risks and complex conditions, enabling healthcare professionals to intervene at an earlier stage. This can lead to more timely and effective treatments, ultimately improving patient outcomes.

Furthermore, AI has the potential to accelerate the pace of medical research and enhance clinical decision-making. By analyzing large volumes of healthcare data, AI can help identify patterns and trends that may not be readily apparent to human practitioners. This can support healthcare professionals in making more informed decisions about patient care, treatment strategies, and resource allocation.

The integration of AI in medicine also holds promise for improving patient experiences and outcomes. Through the analysis of data collected from various sources such as Big Data, AI can contribute to personalized medicine, where treatments are tailored to individual patients based on their unique characteristics and medical histories. This has the potential to lead to more effective and targeted interventions, as well as a reduction in adverse events.

It's important to note that the widespread adoption of AI in healthcare will require careful consideration of regulatory approval, integration with existing health systems, and standardization to ensure the reliability and interoperability of AI applications. Despite these challenges, the potential benefits of AI in healthcare are substantial, and the continued advancement of this technology is expected to play a transformative role in the future of medicine (Telefónica, 2023).

The growth of AI in healthcare has been significant. According to a report by CB Insights, 86% of organizations providing healthcare services were already using AI in 2016. The COVID-19 pandemic has further accelerated the integration of AI into modern healthcare, highlighting its importance in addressing healthcare challenges. As a result, AI is expected to become an integral part of healthcare, with its applications ranging from clinical decision support to personalized medicine, ultimately reshaping the practice of medicine as we know it today.

#### 5. How it will impact on suppliers

The application of AI in healthcare has the potential to significantly impact suppliers in the industry. Some of the ways AI will affect suppliers include:

- **Improved supply chain management:** AI can help manage the healthcare supply chain by monitoring and tracking medical equipment and vaccines across the supply chain, ensuring that patients have access to the necessary medications when they need them (Merck, 2023). AI-powered systems can predict demand and aid in forecasting, allowing for better inventory management and reducing the need for human intervention (HealthcareDive, 2023).

- **Enhanced procurement and purchasing processes:** AI capabilities in procure-to-pay (P2P) automation can analyze large volumes of purchasing and procurement data, leading to more efficient and accurate processes (HealthcareDive, 2023). This can help suppliers maintain up-to-the-minute inventory management and improve real-time inventory tracking(HealthcareDive, 2023).
- **Data-based forecasting and planning:** AI can integrate with supplier networks to improve data-based forecasting and planning, leading to more effective supply chain management . This can help suppliers better align their production and distribution processes with the evolving needs of healthcare institutions.
- **Deeper supplier and vendor choices and relationships:** AI-powered P2P software can integrate with supplier networks, allowing suppliers to gain deeper insights into their performance and relationships with healthcare providers(Healthcare Dive, 2023). This can help suppliers identify areas for improvement and create more value for their customers.
- **Compliance and quality management:** AI can help healthcare suppliers maintain compliance with regulations and industry standards, as well as manage quality in their processes and products (PMC, 2023). This can lead to better patient outcomes and increased trust in the healthcare system.
- **Market disruption:** AI-based supply chains have the potential to disrupt the healthcare industry, offering new sources of competitive advantage and innovative solutions to traditional supply chain challenges (PMC, 2023). Suppliers that adopt and integrate AI into their operations may gain a competitive edge in the market.

The integration of AI in healthcare supply chains will have a significant impact on suppliers, offering new opportunities for improvement, efficiency, and competitiveness. Suppliers that embrace AI and integrate it into their operations may stand to benefit from these advancements and remain competitive in the evolving healthcare market.

## Customer benefits

AI is expected to bring several benefits to clients in the healthcare sector. Some of the key benefits include:

- **Improved diagnostic speed and accuracy:** AI algorithms can process large amounts of data quickly and accurately, making it easier for healthcare providers to diagnose and treat diseases. This can lead to better patient outcomes and improved quality of life (IBM, 2023).
- **Better management of chronic conditions:** AI can help healthcare providers monitor patients' health data over time and provide recommendations for lifestyle changes. This can lead to improved patient outcomes and reduced healthcare costs (IBM, 2023).
- **Increased access to care:** AI can improve access to care by enabling providers to reach more patients, especially in remote and underserved areas. This can help bridge the gap in healthcare access and improve overall health outcomes (IBM, 2023).
- **Streamlined tasks and operational efficiencies:** AI can be used to automate tasks and improve operational efficiencies, benefiting both potential and existing patients. This can lead to reduced wait times and improved patient satisfaction (IBM, 2023).
- **Detection and tracking of infectious disease:** AI can be used to detect and track infectious diseases, such as COVID-19, tuberculosis, and malaria. This can help healthcare providers respond more effectively to outbreaks and improve public health outcomes (IBM, 2023).
- **Personalized medicine:** AI can analyze large amounts of data to develop personalized treatment plans for patients, taking into account their medical history, lifestyle, and genetic factors. This can lead to more tailored and effective treatments.

- **Healthcare fraud detection:** AI can be used to analyze healthcare data to identify potential fraud, such as false claims or over-billing. This can help healthcare providers and insurance companies save money and ensure that resources are allocated efficiently.
- **Improved patient engagement:** AI can be used to create chatbots and virtual assistants that engage with patients, providing information and support. This can improve patient satisfaction and adherence to treatment plans.
- **Research and drug development:** AI can be used to analyze large amounts of data from clinical trials and other research to accelerate the development of new drugs and treatments. This can lead to faster breakthroughs and improved patient outcomes.

AI has the potential to transform the healthcare sector by improving diagnostic accuracy, streamlining tasks, and providing personalized care, and it can also help detect and track infectious diseases, improve access to care, and accelerate research and drug development. These benefits can lead to better patient outcomes, improved quality of life, and reduced healthcare costs.

## What is it expected to improve

AI in healthcare is expected to improve different areas in the healthcare industry like in diagnostics, treatment planning, patient management, and overall efficiency in operations. Some of the key benefits of AI in healthcare include:

**Early disease detection:** AI algorithms can analyze large amounts of medical data to predict potential diseases, leading to earlier detection and treatment. According to Harvard's School of Public Health, although it's early days for this use, using AI to make diagnoses may reduce treatment costs by up to 50% and improve health outcomes by 40%.

**Personalized medicine:** AI can help create customized treatment plans based on an individual's genetic makeup, lifestyle, and medical history, leading to more effective and tailored care.

**Cost reductions:** AI can shift the healthcare model from reactive to proactive approach, reducing healthcare costs by predicting diseases and identifying errors.

**Improved diagnostic accuracy:** AI can analyze medical data more accurately than humans, leading to better diagnosis and treatment decisions.

**Enhanced operational efficiency:** AI can help healthcare professionals automate daily tasks, reduce human errors, and improve overall operational efficiency.

**Better patient management:** AI can assist in managing patient data, appointments, and medication, leading to improved patient care and outcomes.

As AI technology continues to advance and its benefits become more evident, it is expected that the adoption of AI in healthcare will continue to grow and improve the healthcare industry (IBM, 2023), (Binarks, 2023).

## What are the risks

### 1. Data Privacy Concerns:

The implementation of AI presents risks associated with synthetic patient data, this includes:

- **Privacy and Data Protection:** Utilizing artificial data generated from confidential medical details raises apprehensions regarding potential breaches of privacy and principles related to safeguarding data. (Giuffrè & Shung, 2023).

- **Regulatory Blind Spots:** The lack of precise laws regarding synthetic data usage leads to regulatory gaps, which might jeopardize the privacy of patient data. (Arora & Arora, 2023).
- **Data Re-identification:** Even though synthetic data can enhance individual privacy by increasing the difficulty of re-identifying records, there remain potential risks such as data leakage and reliance on imputation models. (Gonzales A, Guruswamy G, Smith SR, 2023).
- **Bias and Discrimination:** Potential prejudice in healthcare AI models may result from the use of synthetic data that replicates and amplifies pre-existing biases in the source data. (Talby, 2023).

## 2. Reliability Issues:

While there are many advantages to AI systems, they are not perfect and may provide incorrect diagnoses or suggestions, which could lead to patient harm or other issues with healthcare (W. Nicholson Price II, 2019). The reliability of AI models in a healthcare setting is critical, including accuracy, clinical application fit, moral objectivity in judgment, and patient and expert acceptance of these systems (Balagurunathan, Mitchell & El Naqa, 2021). There are now questions about how well AI can diagnose illnesses or recommend therapies, which could have an effect on patient-provider interactions and health outcomes (Berry, 2023). While AI has the potential to improve diagnostic efficiency and speed in the healthcare industry, patient safety and the overall efficacy of AI tools in the field depend heavily on the careful management of risks associated with erroneous predictions and diagnoses (Moore, 2023).

## 3. Ethical Concerns:

The ethical concerns surrounding the use of artificial intelligence in healthcare are significant and multifaceted. They include the following:

- **Informed Consent:** Guaranteeing that patients receive sufficient information regarding the utilization of AI in their treatment and enabling them to provide consent for its application (Front. Surg., 2022).
- **Safety and Transparency:** Ensuring the safety and transparency of AI systems is essential to prevent potential harm to patients and to guarantee that these systems operate in a clear and explicable manner (Front. Surg., 2022).
- **Algorithmic Fairness and Biases:** The possibility that AI algorithms would have biases that could lead to unfair treatment or inaccurate information, endangering inclusivity, equity, and health (World Health Organization, 2023).
- **Data Privacy:** Ensuring the protection of patient data within AI systems to prevent unauthorized access or misuse (Gerke, S., Minssen, T., & Cohen, G., 2020).

## 4. Lack of Human Touch:

Concerns about the potential loss of human interaction in patient care are raised by the use of artificial intelligence in healthcare. Patients typically expect individualized treatment and attention from human physicians as well as emotional understanding and empathy—qualities that AI systems might not provide (Castro, 2023)(Byrne, 2023). There's a significant concern about integrating AI into healthcare without compromising the vital human connection essential for patient care (ESoftSkills, 2023). Additionally, relying too heavily on AI might cause patients to perceive themselves as data points or algorithms, potentially endangering their autonomy and diminishing the sense of empathy (Byrne, 2023). Additionally, prejudiced AI models may cause health risks in particular patient demographics to be overestimated or underestimated, presenting issues with societal discrimination and patient welfare (Esmaeilzadeh, P., Mirzaei, T., & Dharanikota, S., 2021).



## 5. Data Security Risks:

Employing artificial intelligence in healthcare introduces notable data security risks, encompassing potential breaches, privacy infringements, and unauthorized access to patient information. Absent appropriate safeguards and regulatory assurances, AI implementation could endanger patient data security and privacy (TechTarget, 2021) (TechTarget, 2017). AI models have the capacity to manage a substantial volume of data, often necessitating access to significant amounts of patient data. This situation raises apprehensions regarding data privacy and cybersecurity issues (TechTarget, 2021). Moreover, the absence of interoperability among AI vendors and the concentration of AI platforms within vendor data centers can exacerbate security and privacy risks (TechTarget, 2017).

## 6. Job Displacement Concerns:

It is anticipated that the application of AI in healthcare would impact several positions. Even though AI is unlikely to completely replace some jobs, it could have an impact on the activities and nature of work. In the healthcare industry, some positions that are more likely to be replaced by AI are as follows:

- **Data Entry and Processing:** AI is more likely to automate tasks related to data entry, rudimentary transaction processing, and basic customer service responsibilities (Pelta, 2023).
- **Routine Administrative Tasks:** Routine administrative jobs, such as bookkeeping and simple financial analysis, are more likely to be replaced by AI (Pelta, 2023).
- **Clerical Work in Professional Occupations:** AI is increasingly prevalent in jobs involving more secretarial labor in the legal, financial, and business management sectors (Diaz, 2023).
- **Certain Diagnostic and Analytical Tasks:** AI-powered diagnostic tools in healthcare possess the potential to automate certain diagnostic and analytical procedures, yet they are more inclined to augment rather than entirely supplant the tasks performed by healthcare professionals (Diaz, 2023).
- **Tasks Requiring Language-Oriented and Structured Data Analysis:** Legal services and market research analysis are two professions that could be automated by artificial intelligence (AI). These jobs involve language-oriented, structured data processing (Zinkula & Mok, 2023).

Even though AI might not completely replace these positions, it is anticipated to alter the nature of work and the activities involved, changing the need for particular talents and opening up new career options. Examples of these are machine learning engineers and data scientists in the healthcare industry (Thaler, 2023).

# 06



## Case studies

These case studies show how AI has the potential to revolutionize the healthcare industry by strengthening diagnostics and prognostics, speeding up medical procedures, and increasing access to high-quality care. AI is still developing, which indicates that future breakthroughs in the healthcare industry could be even more significant.

Table 3. Case studies

	Case 1	Case 2	Case 3	Case 4	Case 5
<b>Category 1: Clinical Decision Support Systems</b>	Kettering General Hospital - England	Valley Medical Center in Renton - USA	Qventus - USA	One Drop - USA	H2O.ai - USA
<b>Category 2: Diagnosis and Treatment Recommendations</b>	Subtle Medical - USA	Vigilanz-USA	PathAI - USA	Enlitic - USA	Viz.ai - USA
<b>Category 3: Patient Engagement and Adherence</b>	Cleveland Clinic - USA	OneCare - India	AllazoHealth - USA	The Centers for Medicare and Medicaid Services (CMS) - USA	Oracle Cerner - USA

Table 3. Case studies continuing

	Case 1	Case 2	Case 3	Case 4	Case 5
<b>Category 4: Administrative Activities</b>	Johns Hopkins Hospital - USA	Sensely - USA	Hardin Memorial Health - USA	Doximity - USA	Infosys - INDIA
<b>Category 5: Healthcare Research</b>	Discovery Accelerator Center - USA	Bristol Myers Squibb - USA	University of Washington - USA	International Human Cell Atlas Consortium - USA - UK	Beth Israel Deaconess Medical Center - USA
<b>Category 6: Robotics and Surgery</b>	Intuitive - USA (Da Vinci)	Asensus Surgical - USA (Senhance)	Auris Health - USA	CMR Surgical - UK	eCential Robotics - France
<b>Category 7: Preventive Health and Risk Assessment</b>	XtalPi - USA	University of Hawai'i at Mānoa - USA	IBM Watson for Genomics - North America, Asia and Europe	Webiomed - Russia	Mayo Clinic - USA

## Category 1: Clinical Decision Support Systems

### Improving patient bed allocation

- Kettering General Hospital**

In England, hospitals, like Kettering General Hospital (KGH), often face challenges in efficiently managing bed space. To tackle this, the Accelerated Capability Environment (ACE) partnered with KGH to explore how artificial intelligence (AI) could help make better decisions about allocating patient beds.

Allocating beds is a bit like playing a complex game—similar to Tetris—where human schedulers work hard to match patients with the right beds, considering their needs, available resources, and time constraints. ACE, along with KGH and the NHS England AI Lab, developed a trial version of an AI-supported tool to manage how patients move through the hospital.

This tool uses past data to predict future demand for beds, suggests beds for emergency admissions, and explains its suggestions clearly to build trust. Importantly, it keeps humans involved in the decision-making process, ensuring that final decisions about bed allocation are made by human schedulers.

The next steps involve testing the tool with users and expanding its capabilities to support different types of patients and beds across various healthcare institutions in England. (GOV.UK, 2023)

### **AI offers clinical decision support**

- **Valley Medical Center**

In the Valley Medical Center in Renton, WA, the facility identified challenges where clinicians were spending excessive time searching for information. To address this issue, the hospital collaborated with IBM to integrate IBM Micromedex with Watson, a clinical decision support software. This artificial intelligence solution integrates clinical decision support and AI with patients' electronic medical records, streamlining the retrieval of relevant and valuable information.

For TidalHealth, this meant reducing the time healthcare providers dedicate to clinical searches. The numerous steps involved in the process, coupled with the frequent need to perform it multiple times during a single shift, consumed a significant amount of providers' time.

With the assistance of a reliable AI tool that facilitates more efficient information retrieval, the hospital successfully reduced the time spent on each clinical search from 3 to 4 minutes to less than 1 minute. This optimization by AI translates to more time available for medical professionals to engage with patients daily, as it efficiently addresses a previously time-consuming process.

(Xsolis, n.d.)

## **IBM MICROMEDEX INTEGRATION WITH WATSON**



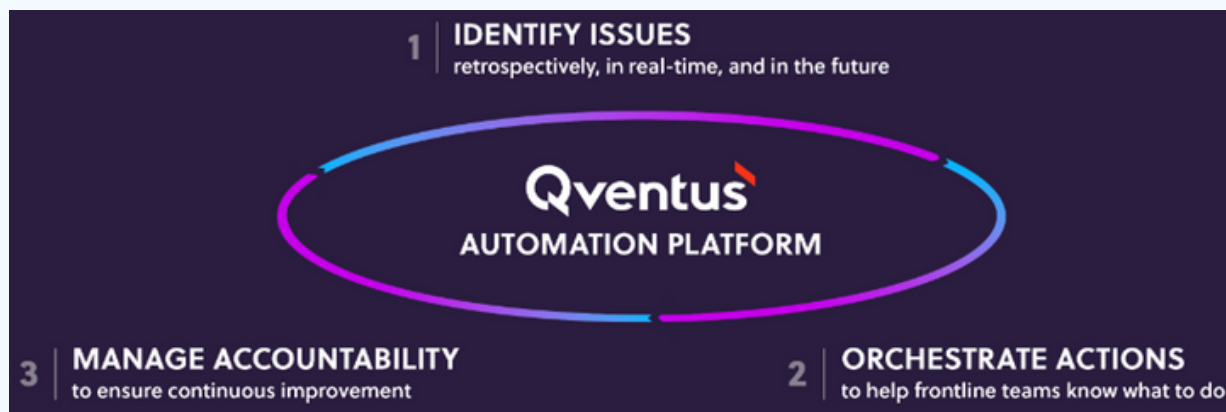
## AI and ML Progress in Clinical Decision Support

Artificial intelligence (AI) and machine learning (ML) models continue to evolve clinical decision support systems (CDSS). Recent advances in AI-driven methodologies in intensive patient monitoring open new horizons for the integration of clinical decision support into practice. However, regardless of being fully automated or requiring expert input or annotation, AI-assisted methodologies for clinical decision support are intended to function as a complementary aid to the subjective decisions of clinicians and intensivists rather than acting in full autonomy (Moazemi et al., 2023).

- **Qventus**

Qventus, an American company, offers an AI-driven software platform addressing operational issues, particularly in emergency rooms, and enhancing patient safety. Their automated system effectively prioritizes patient illnesses and injuries while monitoring hospital wait times, assisting healthcare facilities in optimizing the delivery of care (Daley Sam, 2023).

### AUTOMATION PLATFORM

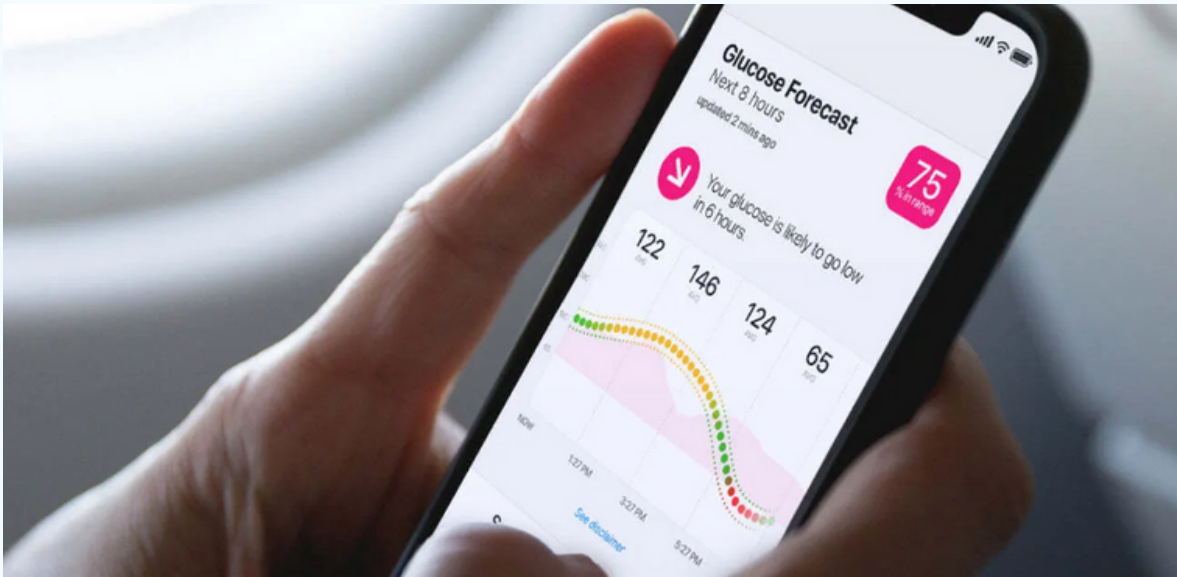


Source: Qventus, 2024

- **One Drop**

One Drop, another American company, offers a discrete solution for overseeing chronic conditions like diabetes, high blood pressure, and weight management. Through the One Drop Premium app, individuals can effectively manage their health conditions, benefiting from interactive coaching by real-world professionals, AI-powered predictive glucose readings, learning resources, and daily tracking of readings from One Drop's Bluetooth-enabled glucose reader and other devices (Daley Sam, 2023).

## ONE DROP PLATFORM

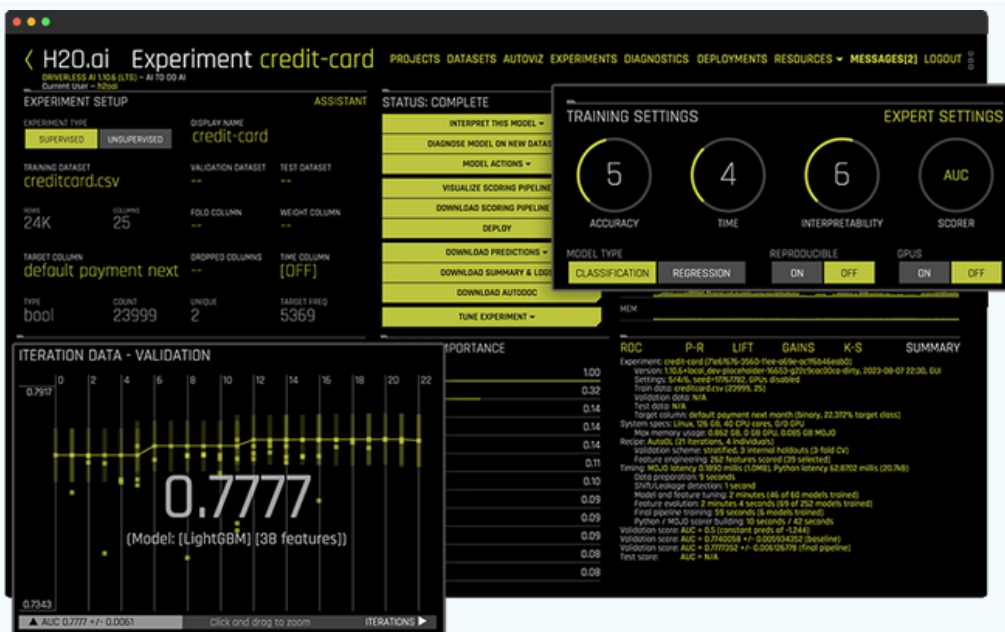


Source: One Drop, 2024

- **H2O.ai**

H2O.ai, an American company, analyzes data throughout a healthcare system to extract, automate, and predict processes. It has proven effective in predicting ICU (Intensive Care Unit) transfers, enhancing clinical workflows, and assessing a patient's risk of hospital-acquired infections. By leveraging the company's artificial intelligence for mining healthcare data, hospitals can anticipate and identify sepsis, leading to a reduction in mortality rates (Daley Sam, 2023).

## H2O.AI PLATFORM



Source: H2O.ai, 2024

## Implications of implementing AI on Clinical Decision Support Systems

- Improved Diagnostic Accuracy: AI-driven support systems are capable of analyzing intricate medical data, which results in quicker, more precise diagnoses with a lower chance of error.
- Proactive Interventions: Healthcare providers can improve patient outcomes and stop the course of diseases by taking proactive interventions as soon as possible after identifying possible health risks.
- Reduction of Medical Errors: Clinical decision support systems can help reduce medical errors by offering data-driven, real-time insights. This improves patient safety and the standard of care as a whole.

## Category 2: Diagnosis and Treatment Recommendations

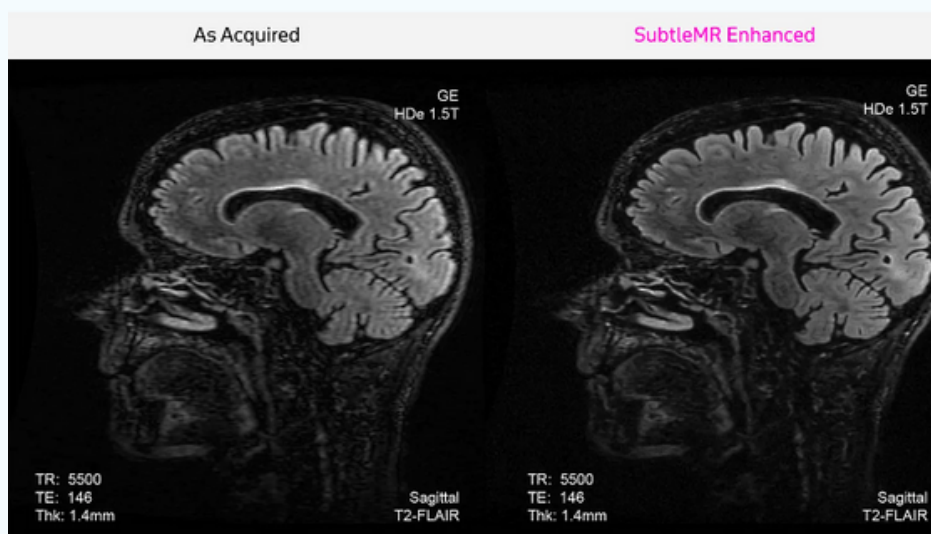
### Medical Imaging

- **SubtleMR**

Despite many technological advancements, medical image analysis remains a laborious task prone to human error due to the need for meticulous attention to detail. Machine learning offers a solution by enabling the detection of even the most subtle changes in medical scans. Additionally, traditional scan analyses, such as CAT scans and MRI, are time-consuming.

As an example, SubtleMR, developed by Subtle Medical, is a software solution based on machine learning that enhances the quality of MRI protocols. Through denoising and resolution enhancement, SubtleMR can augment image quality and sharpness across various MRI scanners and field strengths. For instance, RadNet, a prominent provider of outpatient imaging with 335 centers nationwide, experienced a 33-45% acceleration in protocols upon implementing SubtleMR technology. (Medium, 2023)

## SUBTLE MEDICAL IMAGE



Source: Subtlemedical, 2023

## Optimizing Medication Management through AI Integration

- **VigiLanz**

AI aids pharmacists in handling medication-related responsibilities, utilizing its capability to analyze patient medical records and medication histories to identify potential drug interactions, allergies, or contraindications. Through real-time alerts and recommendations, AI-powered systems contribute to enhancing the safety and precision of medication dispensing by pharmacists (Retail Solutions, 2023). This can improve medication management and reduce the risk of medication-related adverse events by increasing patient safety and improving patient health (Manas Dave & Neil Patel, 2023).

VigiLanz, an American EHR clinical surveillance company, recognizes the transformative potential of employing AI for medication management and error prevention (Loria Keith, 2023). They provide, through their pharmacy surveillance software, near real-time alerts and data monitoring, enabling pharmacy managers to improve the medication use process (Pharmacy Workflow Solutions, 2023).

### RESULTS

**48%**

decrease in hyperglycemia among  
AECOPD patients.

**30%**

decrease in severe hypoglycemic  
events in patients with a prior  
hypoglycemic event.

Source: VigiLanz, 2021

## AI Empowers More Accurate Diagnoses in Healthcare

AI-driven diagnostics have the potential to revolutionize disease detection and prevention, significantly improving health outcomes. These systems exhibit remarkable accuracy in identifying diseases early by analyzing extensive medical data from diverse sources, such as electronic health records, lab reports, and imaging tests like X-rays, CT scans, and MRI scans. By comprehensively assessing this data, AI algorithms can unveil subtle patterns or abnormalities that may elude human observation, leading to more precise diagnoses and reducing the risk of misdiagnosis. Furthermore, these systems continuously learn and enhance their accuracy over time, enabling them to identify diseases even earlier when more effective treatment options are available (Analytics, 2023).

- **PathAI**

PathAI, an American company, is advancing machine learning technology to support pathologists in achieving more precise diagnoses. The company's primary objectives involve minimizing errors in cancer diagnosis and creating approaches for personalized medical treatments. Collaborating with entities like Bristol-Myers Squibb and the Bill & Melinda Gates Foundation, PathAI extends its artificial intelligence technology beyond pathology to benefit various healthcare sectors (Daley Sam, 2023).



- **Enlitic**

Enlitic, is another American company that specializes in creating deep learning medical tools designed to streamline radiological diagnoses. Its deep learning platform processes unstructured medical data, including radiology images, blood tests, electrocardiograms, genomics, and patient medical history, providing doctors with real-time insights into patient needs (Daley Sam, 2023).

### **AI Advancements Revolutionizing Medical Issue Detection**

- **Viz.ai**

AI in healthcare excels at early disease detection (e.g., skin lesions, lung nodules, heart murmurs) and risk assessment based on genetic, environmental, and lifestyle data. It also facilitates non-invasive population screening using methods like smartphone apps and facial recognition. Continuous monitoring by AI identifies changes, offering crucial insights into disease progression or recurrence (How can AI detect diseases earlier?, 2023)

Viz.ai, an American company, uses artificial intelligence to speed up care coordination, reducing systemic delays that stand between patients and life-saving treatments (Viz.ai, 2023). In critical situations where time is a matter of life and death, Viz.ai empowers care teams with AI-driven healthcare solutions. The company's AI products swiftly detect issues, promptly notifying care teams. This enables providers to expedite discussions, make treatment decisions faster, and ultimately save lives (Daley Sam, 2023).

### **Implications of implementing AI on Diagnosis and Treatment Recommendations**

- Diagnoses can be made more quickly and accurately thanks to AI's ability to evaluate large datasets, which also makes it easier to start treatment programs on time.
- AI algorithms have the capability to examine specific patient data and create customized treatment strategies that maximize positive outcomes and reduce negative ones.
- Effective Treatment Alternatives: By evaluating past data and forecasting outcomes, AI can help find the best possible treatments, resulting in more focused and effective healthcare plans.

### **Category 3: Patient Engagement and Adherence**

#### **Uses AI to personalize healthcare plans**

- **The Cleveland Clinic**

The Cleveland Clinic, located in Cleveland, Ohio, has partnered with IBM to incorporate artificial intelligence into its IT systems. This renowned hospital is leveraging AI to collect data from numerous administrative and health record points, totaling in the trillions, to make the patient experience more efficient. By combining AI with extensive data, the Cleveland Clinic aims to personalize healthcare plans for each individual, enhancing the overall quality of patient care (Mahendra, 2023).

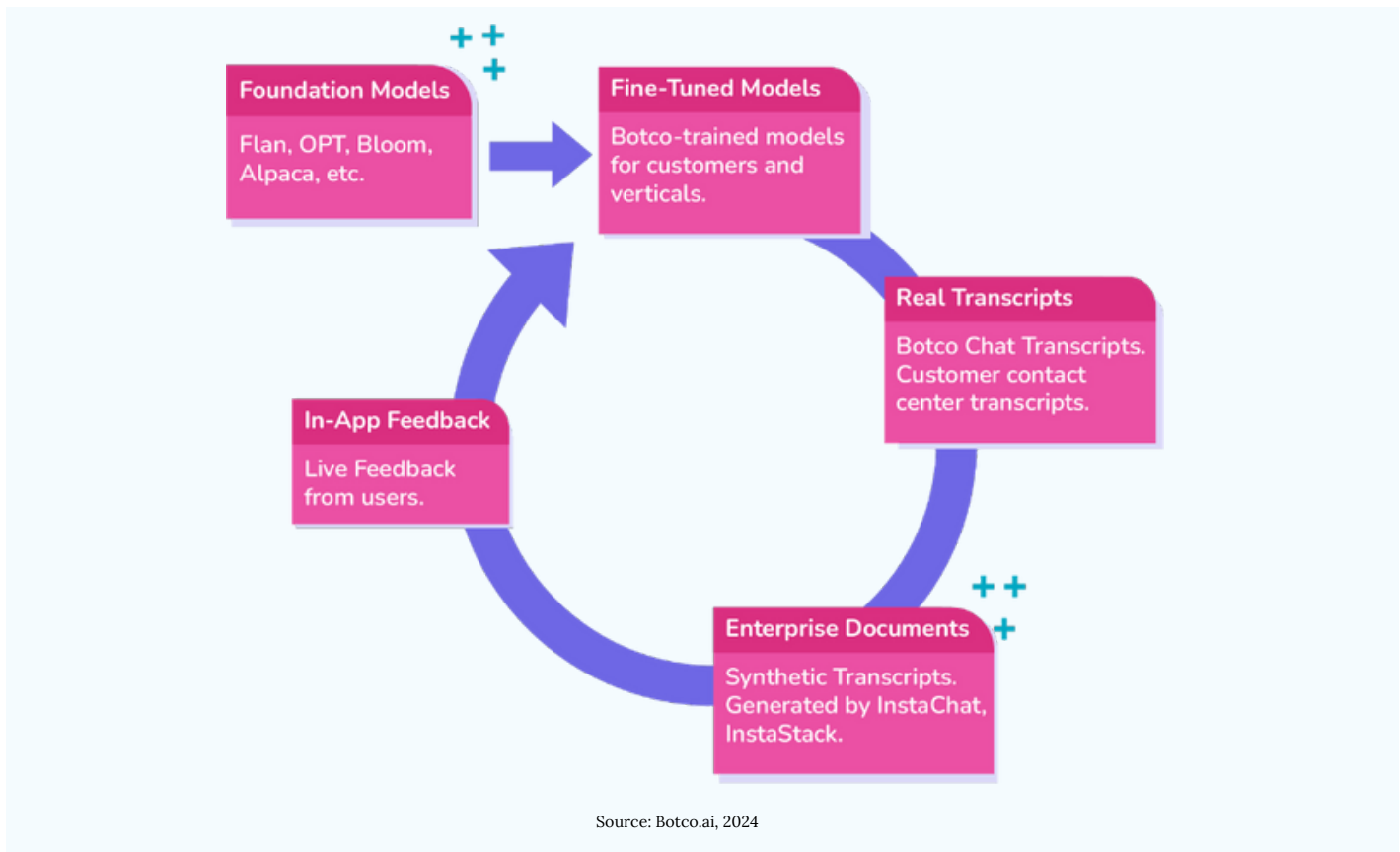
#### **Enhancing Patient-Centered Clinical Care**

- **OneCare**

Artificial Intelligence (AI) can enhance patient adherence by issuing reminders, overseeing potential side effects, and delivering individualized information and assistance. When patients receive personalized guidance and encouragement, they are more inclined to adhere to their treatment plans, ultimately resulting in improved health outcomes (Sinha Soham, 2023).

OneCare, a Health Care Service platform, employs Botco.ai's chatbot, powered by generative AI, to establish a smooth communication link among doctors/consultants, service providers, family members, and employers. This facilitates the monitoring and tracking of patients' health and well-being. The chatbot has the capability to comprehend and address diverse queries, offering valuable details about medical procedures, treatment plans, and strategies for health management. Through the utilization of generative AI, OneCare guarantees the provision of precise information and guidance to patients, thereby enhancing their overall healthcare journey. The outcome is enhanced communication, increased patient involvement, and greater efficiency in healthcare services (Botco.ai, 2023).

## GENAI POWERED CHATBOTS



### Optimizing Patient Support Programs Through the Integration of Artificial Intelligence

- **AllazoHealth**

Artificial intelligence (AI) is pivotal in shaping contemporary and streamlined patient support programs, contributing significantly to their efficiency and effectiveness. These AI-driven programs not only optimize interventions but also yield cost savings (AllazoHealth, 2022).

AllazoHealth, an American software company, developed its artificial intelligence technology with the aim of facilitating personalized patient engagement, enhancing initiation, medication adherence, overall patient experience, and health outcomes. Simultaneously, this technology works towards optimizing program performance, reducing costs, and improving operational efficiency (AllazoHealth, n.d.).

AllazoHealth's artificial intelligence platform utilizes patient-level identified data in a secure and compatible manner to discern the ideal channels, content, timing, cadence, and risk factors for each individual patient. This capability enables you to engage with patients on their terms, delivering precisely tailored support exactly when they need it (AllazoHealth, n.d.).

## ALLAZOHEALTH OUTCOMES

### AllazoHealth outcomes by the numbers

7.8%

increase in therapy initiation rate\*

5.5x

greater medication adherence program performance

13%

increase in days on therapy

25%

lower spending on pharmaceutical interventions

Source: Allazo Health, 2024

### Empowering Remote Patient Care

- **The Centers for Medicare and Medicaid Services (CMS)**

The pandemic accelerated the adoption of telehealth, and healthcare experts worldwide are increasingly focused on the potential impact of AI on addressing persistent challenges in remote patient monitoring (RPM). Issues like the expanding elderly population and the global shortage of healthcare professionals are now under scrutiny. RPM has facilitated the acquisition of real-time health information, allowing physicians to expedite home care (KMS, 2023).

Utilizing wearables and various home devices, AI continuously gathers and analyzes patient data, enhancing the effective monitoring of individuals with chronic illnesses. Through real-time identification of crucial health trends or anomalies, AI delivers timely alerts to caregivers, facilitating early intervention and ultimately minimizing hospital readmissions (Jorie AI, n.d.).

The Centers for Medicare and Medicaid Services (CMS), a significant authority responsible for establishing care standards in the US healthcare system, has been incorporating CPT (Current Procedural Terminology) codes for remote therapeutic monitoring (RTM) since 2018. As of 2022, these codes have expanded to encompass RTM services for respiratory diseases and musculoskeletal (MSK) conditions, encompassing remote physical therapy and inhaler monitoring for COPD. Moreover, prominent corporations including Google, Apple, Samsung, and Amazon have entered the arena by introducing their own SMART on FHIR applications. This successful integration has effectively blurred the distinctions between healthcare entities and consumer-focused technology companies (KMS, 2023).

### Patient Engagement Through Patient Portals

- **Oracle Cerner**

A patient portal is a secure online platform that enables individuals to access their medical records, communicate with healthcare providers, schedule appointments, and monitor their treatment progress. These portals have evolved into integral components of electronic health record (EHR) systems, facilitating patient engagement, fostering collaboration, supporting revenue cycle management, and streamlining various healthcare processes (Dhaval Desai, 2023).

Oracle Cerner, a US-based supplier of health information technology platform, has HealthLife SM, a web-based solution fostering interaction and engagement between healthcare organizations and individuals within their population. This platform seamlessly integrates the conventional features of a patient portal with engagement tools, empowering individuals to take a proactive role in managing their health (Cerner, n.d.).

Moreover, Cerner offers CareAware myStation, an interactive patient system designed to keep patients and their families engaged and well-informed about the care provided during their hospital stay. This solution delivers comprehensive bedside education, communication, and entertainment. Notably, it stands out as the sole interactive patient system seamlessly integrated with Cerner Millennium's electronic health record (EHR) (Cerner, n.d.)

### **Implications of implementing AI on Patient Engagement and Adherence**

- Personalized and easily comprehensible health information can be provided via AI-powered technologies, which can improve patient education and participation.
- Better medication Adherence: AI-powered monitoring programs and reminders can increase drug adherence, which can improve health outcomes and the management of chronic illnesses.
- Personalized Health suggestions: AI may evaluate patient data to provide tailored health suggestions that promote proactive health management and plan adherence.

### **Category 4: Administrative Activities**

#### **Faster hospital visits, courtesy of AI**

- **Johns Hopkins Hospital**

Johns Hopkins Hospital in Maryland, USA, collaborated with GE to boost the efficiency of patient operations through predictive AI techniques. With the aid of an AI-supported task force, the hospital swiftly prioritized its activities to improve services for all patients. Since the implementation of this program, the hospital has experienced a significant 60% improvement in admitting patients and a 21% increase in patient discharges before noon. This progress results in a faster and more positive experience for patients. (Data Core Healthcare, 2022)

In February 2022, a survey showed that Singapore led in the adoption of predictive analytics in healthcare, with 92% of healthcare leaders stating they had already adopted or were in the process of adopting this technology. China followed in second place with a 79% adoption rate, while Brazil and USA were tied at 66%.

This indicates the widespread embrace of predictive analytics in healthcare organizations, with Singapore taking the lead in this global trend. (Stewart, 2022).

- **Sensely**

Sensely is an American empathy-driven conversational platform powered by world-class content, designed to enhance the member experience, elevate brand preference, and influence behavior. Sensely's avatar and chatbot-based platforms assist insurance plan members and patients with the insurance services and healthcare resources they need, when they need it. By utilizing Sensely's scalable platform technology architecture, enterprises can converse with their members in an entirely new way, combining the empathy of human conversation with the efficiency and scalability of technology. Sensely's global teams provide virtual assistant solutions to insurance companies, pharmaceutical clients, and hospital systems worldwide (Sensely, 2022).

## SENSELY SOLUTION



Source: Sensely, 2024

The Sensely app serves as an artificial intelligence platform that facilitates conversational interactions between patients and various entities within the healthcare sector, such as pharmaceutical companies, insurers, employers and medical service providers (Sensely, n. d.)

Rather than offering a conventional chatbot experience, Sensely presents itself as an artificial intelligence medical assistant that employs various types of avatars to infuse personality into each interaction. This application is capable of handling various customer service functions, easing the company's workload and providing a seamless experience (Intech\_wtc & Intech\_wtc, 2021).

Sensely is configured to accommodate diverse patient populations and address a wide range of medical concerns. To achieve this, it employs a rules-based engine and algorithm to deliver a personalized experience suited to each patient's unique situation (Intech\_wtc & Intech\_wtc, 2021).

### Consolidating Patient Information

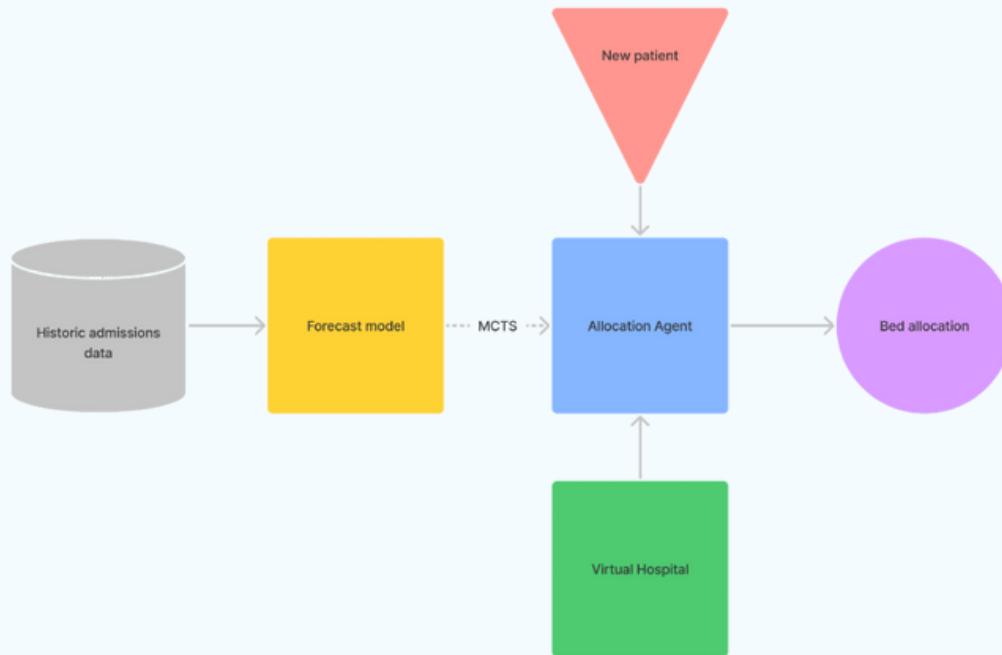
- **Hardin Memorial Health**

The ability of AI to interpret massive, unstructured data sets is one of its biggest benefits in healthcare. To take advantage of this, Hardin Memorial Health in Elizabethtown, Kentucky, combined patient records utilizing AI analytical software.

The radiology department of the hospital extracted pertinent information from electronic health records (EHRs) using a pre-made AI software. IBM's Watson Imaging Patient Synopsis is a tool that would search patient records for pertinent data, aggregate it, and provide it to radiologists in a single window.

Radiologists could quickly gain a more thorough understanding of patients' health and hazards with this rapid access to information.

## SENSELY SOLUTION



Source: Github, 2022

These kinds of off-the-shelf summary tools could also be used in other areas by hospitals. Almost any procedure can be made more efficient by having a quick, comprehensive picture of the patient's health. But remember that since AI is still not perfect, physicians should always review these records again if taking a different step could have dire repercussions (The Journal of Mhealth, 2022).

### A HIPAA-Compliant AI Writing Assistant

- **Doximity**

Doximity's beta release of ChatGPT tool designed for doctors, with the goal of simplifying administrative paperwork processes. With a commitment to HIPAA (Health Insurance Portability and Accountability Act)-compliance, Doximity GPT ensures the secure transmission and management of user data, providing users with peace of mind regarding privacy and confidentiality

Their features and benefits are:

**AI Peer Review:** They have a library of community-curated prompts to see how your peers are using AI in their workflow.

**HIPAA-Compliance:** Doximity GPT ensures the secure transmission and management of all user data. Our BAA (Business Associate Agreement) with OpenAI includes a zero-data retention policy.

**Advanced Personalization:** Doximity GPT integrates with their Doximity profile to streamline writing tasks, automatically generating letterheads, signature lines, etc.

(Landi, 2023) (Doximity, n.d.)

## SENSELY SOLUTION




### Doximity GPT: A HIPAA-Compliant AI Writing Assistant

Cut the scut with Doximity GPT. Reclaim the time you spend on administrative writing tasks, like drafting prior auth letters, insurance appeals, letters of patient support, and more.

[Sign in to try](#)

[Create Account](#)

 [Why do I need to log in?](#)

Source: Doximity, 2024

### Improving Electronic Health Records Using AI

- **Infosys**

Electronic health records (EHRs) play a crucial role in contemporary healthcare delivery, and the utilization of AI technology is becoming progressively indispensable for their management. Medical practitioners can leverage AI to scrutinize extensive medical data, recognizing patterns and trends that contribute to disease prevention and treatment. AI algorithms have the capacity to analyze EHR data comprehensively, aiding medical professionals in identifying patients at elevated risk for specific diseases and crafting individualized prevention strategies (LeewayHertz, n.d.)

Infosys, an Indian multinational information technology company, collaborated with a government department, facilitating the integration of electronic medical records. This initiative, known as the Electronic Health Records (EHR) project, empowers general practitioners (GPs) by granting them comprehensive access to patient details. Furthermore, it aids emergency medical professionals in promptly identifying allergies and reviewing the patient's medical history. In order to ensure that healthcare providers stay updated on the latest advancements, Infosys innovated a Knowledge Management (KM) portal subsystem, contributing to more precise patient outcomes (Infosys, n.d.).

Efficient implementation of value-based care relies on comprehensive patient data across departments. Siloed systems hinder this approach by limiting providers' holistic view of patients. Integrating these systems enables a focus on preventive measures, personalized treatments, and ongoing care management (Venky Ananth, 2023)

### Implications of implementing AI on Administrative Activities

- **Operational Efficiency:** By streamlining procedures and lowering manual labor, AI automation of administrative chores can increase overall operational efficiency.
- **Cost Savings:** Healthcare companies can cut costs by automating repetitive administrative tasks. This frees up funds for patient care and other important initiatives.
- **Better Billing and Scheduling:** AI can streamline billing and scheduling procedures, cutting down on errors and guaranteeing more seamless patient-provider interactions.

### Category 5: Healthcare Research

#### Quantum computers for health research and biomedical discovery

- **Discovery Accelerator Center**

In 2021, IBM and Cleveland Clinic jointly established the Discovery Accelerator Center, marking the initiation of a decade-long collaborative research partnership. The center is dedicated to expediting research in health and life sciences by leveraging IBM's quantum computing, high-performance computing, hybrid cloud, and artificial intelligence technologies (Smith-Goodson, 2023).

#### CLEVELAND CLINIC COMPUTER



Source: Revista Summa, 2024



Projects within the Discovery Accelerator encompass a range of initiatives: developing a quantum computing approach for detecting and optimizing drugs targeting specific proteins; enhancing a predictive model for assessing cardiovascular risk post non-cardiac surgery; and employing artificial intelligence to comb through genome sequencing findings and extensive drug target databases to identify existing drugs beneficial for patients with Alzheimer's and other related illnesses (Clewlow, 2023).

Quantum computing holds vast potential to address critical healthcare challenges. It can revolutionize the discovery of novel molecules, laying the groundwork for groundbreaking pharmaceutical advancements and facilitating the development of new drugs. Moreover, its application could enhance the capacity to derive profound insights from intricate data, addressing fundamental hurdles within healthcare (IBM, 2021).

## **Recruiting participants for clinical trials**

- **Bristol Myers Squibb**

Recruiting individuals for clinical trials is frequently a demanding endeavor; however, artificial intelligence (AI) can enhance its efficiency and precision. AI algorithms have the capability to examine patient data, medical records, and other pertinent information, pinpointing appropriate candidates for particular trials. This capability can expedite the recruitment process, which typically spans months or even years (Clinrol, 2023).

Bristol Myers Squibb (MS), an American multinational pharmaceutical company, has been using AI for recruitment and improving the efficiency of studies in the clinical field. MS employs sophisticated natural language processing (NLP) and machine learning (ML) methodologies to analyze extensive datasets from thousands of patients, enhancing the recruitment process significantly. BMS is at the forefront of efforts to minimize the burden on patients and enhance the overall efficiency of clinical trials. The utilization of advanced technologies, such as NLP and ML, by MS demonstrates a commitment to innovative approaches that pave the way for more effective and patient-friendly trial processes (Alsumidaie, 2023).

## **The power of AI in genomics research**

- **University of Washington**

AI has played a significant role in advancing the treatment of various biomedical conditions, particularly genetic disorders. In both fundamental and applied genetic research, deep learning, a highly adaptable branch of AI capable of autonomous feature extraction, is increasingly being leveraged (Vilhekar RS, 2024).

In certain domains, like clinical genomics, a specialized AI algorithm called deep learning is employed for the analysis of extensive and intricate genomic datasets. Presently, the most encouraging applications of AI in clinical genomics involve the extraction of in-depth phenotypic information from images, electronic health records (EHRs), and other medical devices to guide subsequent genetic analysis. Nevertheless, deep learning algorithms have demonstrated remarkable potential across various clinical genomics tasks, encompassing variant calling, genome annotation, and the prediction of functional impacts (Diaz & Torkamani, 2019).

Machine learning (ML) and deep learning (DL) algorithms have emerged as valuable tools for tackling genetic mutations or variants associated with complex pathological phenotypes. Researchers at the University of Washington have introduced a computational framework named Combined Annotation Dependent Depletion (CADD) to comprehensively assess the effects of genetic variants in the human genome by integrating diverse annotations (News-Medical.net, 2023).

Their approach involved constructing a variant-by-annotation matrix that included millions of observed and simulated genetic variants, each annotated uniquely. Subsequently, they trained a support vector machine (SVM) using features derived from these annotations to assign scores to all potential single nucleotide variants (SNVs) in the human genome. Furthermore, they assessed the SVM's capability to prioritize functional and disease-relevant variants across various pathogenic contexts (News-Medical.net, 2023).

## **AI's Role in Advancing Healthcare Technology Research**

- **The international Human Cell Atlas Consortium**

Research into the application of AI in healthcare continues to accelerate rapidly, and potential use cases are being demonstrated across the health sector (both physical and mental health), including drug discovery, virtual clinical consultation, disease diagnosis, prognosis, medication management and health monitoring (Future Healthc J., 2021).

AI systems rapidly analyze vast amounts of data, proving invaluable, especially in drug discovery amid growing complex datasets. Leveraging data-driven and AI technologies has the potential to expedite drug discovery, cutting costs significantly. This is especially advantageous in research areas with lower financial returns and insufficient incentives for investment, such as drug discovery for rare diseases and those impacting low- and middle-income countries (LMICs) (Wellcome, 2023).

The international Human Cell Atlas Consortium was co-founded in 2016 by Dr. Aviv Regev, then at the Broad Institute of MIT and Harvard (USA), and Dr Sarah Teichmann at the Wellcome Sanger Institute (UK). The collaboration's objective is to establish extensive reference maps of all human cells, serving as a foundation for enhancing our understanding of human health and for diagnosing, monitoring, and treating diseases (humancellatlas, n.d.). Technological advancements and the integration of artificial intelligence enable researchers to analyze substantial volumes of genomic data in a fraction of the time required in previous years (Wellcome, 2023).

## **Innovative Approaches to Sepsis monitoring**

- **Beth Israel Deaconess Medical Center (BIDMC)**

Beth Israel Deaconess Medical Center, a teaching affiliate of Harvard Medical School, uses an intelligent sepsis monitoring system to continuously identify and stratify patients at increased risk for sepsis. They are working with leading machine learning experts at the Courant Institute of Mathematical Sciences to develop machine learning theory to integrate all available continuous demographic, laboratory, radiographic, and hemodynamic data. They will use these algorithms to generate next-generation clinical alerts, contextual information retrieval, and targeted decision support. Furthermore, they are also researching the influence of computerized physician order entry (CPOE) on emergency operations (BIDMC, 2023).

Likewise, medical researchers at Beth Israel Deaconess Medical Center (BIDMC) conducted tests to evaluate the ability of a widely known artificial intelligence chatbot, Chat-GPT 4, to make accurate diagnoses in challenging medical cases. The results of this study revealed that the generative AI accurately selected the correct diagnosis as its top recommendation (Center, 2023).

## Implications of implementing AI on Healthcare Research

- Accelerated Medical Research: AI's rapid large-scale dataset analysis speeds up medical research, resulting in more discoveries and breakthroughs.
- Pattern Recognition: Artificial intelligence (AI) can spot intricate patterns in datasets that humans might find challenging to interpret, assisting researchers in their understanding of disease causes and possible targets for treatment.
- Data-Driven Breakthroughs: AI-driven insights from a variety of datasets can lead to ground-breaking discoveries and inventions, opening up new directions for the study and advancement of medicine.

## Category 6: Robotics and Surgery

### First robotic surgery assistant approved by the FDA

- **Intuitive**

Robots are becoming smarter by incorporating various AI capabilities into their operating systems. Advancements in AI have significantly enhanced the robots' capabilities, allowing them to perform intricate operations with increased efficiency.

One notable application is in robotic surgery, where AI enables surgeons to conduct complex procedures with heightened precision, leading to precise, minimally invasive incisions and stitches. This breakthrough in surgical technology is transformative, as long as human supervision remains a crucial component.

In San Francisco, California, the organization Intuitive has been a trailblazer in the robotic surgery industry through its da Vinci platforms. These robotic surgical assistants were the first to receive FDA approval over 18 years ago. Equipped with cameras, robotic arms, and surgical tools, da Vinci machines facilitate minimally invasive procedures. The platform continually gathers data and provides analytics to surgeons, contributing to the improvement of future surgeries. To date, da Vinci has played a role in over five million operations. (Mahendra,2023)

### DA VINCI XI



Source: Da Vinci, 2024

- **Asensus Surgical's Senhance**

Because robotic assistance in surgery increases precision, allows access to different areas of the human body with minimal penetration and alleviates pressure from human surgeons as robots can take over some parts of the work.

Similar to Intuitive's Da Vinci, the Senhance Surgical system is a console-based, multiarmed surgical system that surgeons can remotely manage. The system largely relies on machine learning and deep learning models to make the most difficult healthcare ideas a reality. A machine learning-driven database, for example, allows surgeons to go through simulation training at the preoperative stage. Based on data from the eye-tracking camera, the system's Intelligent Surgical Unit can automatically alter the camera view during surgeries and predict when a surgeon needs to zoom in or improve images in real time.

**Revolutionary Performance-Guided Surgery:** Senhance keeps time and cost-per-procedure comparable to traditional laparoscopy, bringing the benefits of advanced technology to more patients, more ORs, and more surgeons around the world (Cardon, 2023) (Hale, 2023).

## THE FUTURE OF SURGERY

### System Features

- 1 **Robotic precision**  
Select the appropriate scale to enable precise manipulation during delicate tasks.
- 2 Haptic sensing
- 3 Eye-tracking camera control
- 4 Improved ergonomics
- 5 Open-platform architecture
- 6 3mm and 5mm reusable instrument portfolio
- 7 Digital fulcrum



Source: Asensus Surgical, 2024

- **Auris Health**

The co-founder of the industry leader Intuitive Surgical, which produces the popular da Vinci robot, is leading the firm Auris Health. The ARES robot, also known as the Auris Robotic Endoscopy System (ARES), is a teleoperated robotic system that the business developed. The FDA has approved it for use in patient diagnosis and treatment. The ARES robot uses electromagnetic sensors, accelerometers, or automatic video tracking in conjunction with 3-D maps created from a set of 2-D CT scans to be remotely operated by a certified surgeon at a desktop workstation (IEEE Spectrum, 2016).

Additionally, Auris Health created the MONARCH surgical robot system, which the FDA has cleared for use in urology and bronchoscopy procedures under 510(k) status. MONARCH is intended to give urologists the ability to more precisely access and view inside body parts than they have in the past.

According to the company, urologists can perform both ureteroscopic and percutaneous nephrolithotomy (PCNL) procedures on a single platform with the MONARCH system. The most common surgical stone procedures performed worldwide are ureteroscopic operations, which get more difficult as stone size grows (Robotics247, 2022).

- **CMR Surgical (CMR) - Versius**

**Versius Robotics goes Virtual - CMR Surgical to launch VR training for surgical robot**

Versius is a sophisticated tool to help surgeons deliver the highest quality surgical care to patients. It was designed to support surgeons to perform more minimal access surgery, providing the versatility to operate in the way that's best for their patients, with freedom of port placement and surgical approach.

**Benefits:**

The benefits of minimal access surgery for patients are well proven and include reduced pain and surgical site infection. As well as reduced likelihood of other surgical complications. But we know that minimal access surgery is complex and demanding to perform for a surgeon. Versius offers a tool that can help surgeons to deliver.

**Versius** gives surgeons the flexibility to plan fully robotic procedures, or integrate laparoscopic instruments for specific portions of the procedure according to patient need. Versius is beneficial for surgeons as well since it has an ergonomic console which allows surgeons to sit or stand in a comfortable position during surgery, which has the potential to reduce stress and fatigue.

**OPERATING ERGONOMICALLY**



Source: Versius, 2024

**Alongside their robotics**, CMR Surgical (CMR), a global surgical robotics company, is launching a virtual reality headset and a VR professional education program for the Versius® Surgical Robotic System.

Versius is the first soft-tissue surgical robotics system that includes VR training as part of its surgical team training program, offering surgical teams more options for practicing their abilities.

The Versius Virtual Reality headset is wireless, does not require a PC, and comes in a tiny box for portability and convenience.

Versius Virtual Reality mimics an immersive experience as if you are in an operating room. A virtual assistant guides users through learning objectives, providing support at every step. There is also the option to collaborate with other surgical team members in a virtual setting (CMR Surgical, 2022).

## SURGICAL ROBOTIC SYSTEM



Source: Versius, 2024

### eCential Robotics

- **eCential Robotics - Spin surgery**

A business that specializes in surgical robotics. It creates and distributes a unique technology that combines 2D/3D robotic imaging, real-time navigation, and surgical robots. With 100 patents and seven trademarks, it is pursuing a disruptive innovation strategy. It provides orthopedic and neurosurgeons with user-friendly, cutting-edge technologies for visualizing their surgeries, particularly minimally invasive procedures. The eCential Robotics platform is a universal system that accepts all screws.

eCential Robotics has created a groundbreaking invention that allows third-party developers to create surgical apps on its Open eCential platform. Collaborations have been established with several orthopedic manufacturers, as well as startups in the French environment. eCential Robotics is presenting itself as a leader in the rapidly expanding surgical robotics field, with aspirations to become a global leader in open robotic platforms.

- **Spine surgery system**

The eCential Robotics spine surgery system is an integrated, open platform that incorporates intraoperative 2D/3D imaging, navigation, and robotics into its basic design while also providing stereotaxic guiding.

The system consists of three moveable, interconnected pieces. These include a mobile X-ray C-arm imaging system (Surgivisio Platform), a mobile viewing workstation, and a mobile collaboration robot (CoBot) with a surgical arm. The system has a unified user interface that allows all components and functions, including imaging, navigation, and robotics, to be controlled from a single input and output graphical display screen (Medical Device Network, 2022).

## SPINE SURGERY SYSTEM



Source: eCential Robotics, 2024

### Implications of implementing AI on Robotics and Surgery

- **Surgical Procedure Precision:** AI-assisted robotics can improve surgical precision by minimizing invasiveness and raising procedure accuracy.
- **Shorter Recovery Times:** AI-driven surgical procedures can help patients recover from surgery more quickly, which can reduce hospital stays and postoperative complications.
- **Better Surgical results:** AI can help improve surgical results by providing real-time feedback and support, which will increase treatment success and safety overall.

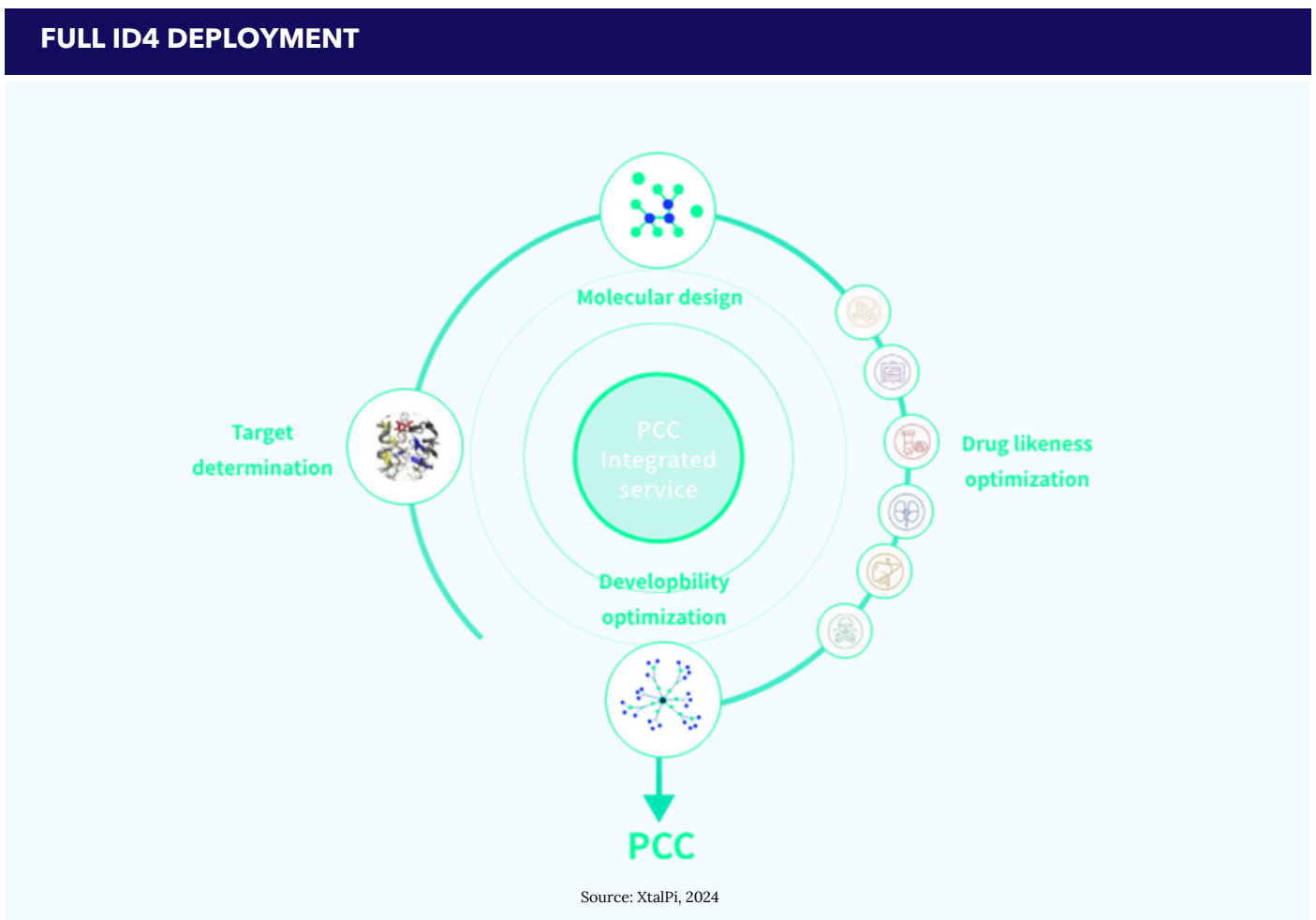
## Category 7: Preventive Health and Risk Assessment

### AI cloud-based digital drug discovery

- **Xtalpi**

In Massachusetts, at Xtalpi, a company combining cloud technology and quantum physics, the ID4 platform predicts the properties of potential drugs on a small-molecule level. Their technology, especially in predicting complex molecular structures, is faster than traditional methods, taking days instead of weeks or months.

The ID4 platform seeks to revolutionize conventional pharmaceutical R&D by expediting the delivery of candidate compounds that offer enhanced speed, scale, novelty, and diversity. Its primary focus lies in hit identification and lead optimization, ultimately generating validated preclinical candidates.



Furthermore, healthcare institutions are increasingly using AI to tackle challenges like rising costs, evolving regulations, and changing demographics. AI is being integrated into various digital solutions, offering significant potential for improving workforce productivity, operational efficiency, risk management, and enhancing the overall patient experience. It's anticipated that within the next three years, 75% of healthcare institutions plan to incorporate AI in some capacity (Data Core Healthcare, 2022).



## AI can predict cancer risk through mammograms

- **University of Hawai'i at Mānoa**

It has been discovered that a complex form of artificial intelligence called deep learning is more effective at utilizing mammograms to distinguish between women who will and will not receive a breast cancer diagnosis in the future than standard clinical risk factors. Mammograms often use measurements of breast density to estimate the risk of breast cancer. Although dense breasts on mammograms are linked to an increased risk of cancer, there are additional potential risk factors that are not seen on mammograms.

A data collection comprising over 25,000 digital screening mammograms from 6,369 women who underwent screening mammography between 2006 and 2014 was utilized in the study. The deep learning algorithm was taught by the researchers to identify features and signals in the mammography that could be associated with a higher risk of cancer. The deep learning-based model performed better when it came to predicting screening-detected cancer risk than clinical risk variables when it came to evaluating interval cancer risk (cancers identified in between routine screenings).

Two groups that have not received enough attention in breast cancer research—Native Hawaiian and Pacific Islander women—will be the subjects of a study replication. Additionally, they wish to look at the risk of various grades of breast cancer, from the least aggressive to the most aggressive, in addition to expanding their research beyond cancer risk. (University of Hawai'i at Mānoa, 2021)

### PROCEDURES



Source: University of Hawai'i at Mānoa, 2024

- **IBM Watson for Genomics**

Globally, breast cancer ranks among the top causes of death for women. Early detection rates have significantly improved, though, because to developments in AI-powered diagnostics. IBM Watson for Genomics' application in breast cancer detection is one instance. Using AI algorithms, this technology examines a patient's genetic information to find trends that might point to a higher risk of breast cancer. Early detection of these warning indicators allows medical professionals to suggest preventive measures or start treatment programs before the illness worsens (Emerging India Analytics, 2023).

This tool is also used as part of routine clinical guidance. Oncologists in this case receive reports that relate the sequencing results of their patients to possible treatment options. Using improved computational technology, this approach—which was once accomplished by a team of oncologists and bioinformaticians doing a lengthy literature search—can now be finished faster. With the implementation of this AI, oncologists may easily access genomic analysis data, which they can utilize to assist them in developing patient-specific therapy regimens. This entails finding mutations that cause cancer and matching those mutations to evidence-based treatment options.

1,018 patients at the University of North Carolina were subjected to Watson genomics testing. Watson for Genomics agreed with the doctors in 99% of the instances, but in almost 300 of them, it discovered additional useful mutations that the tumor board had missed. For each case, the analysis took less than three minutes.

In just a few minutes, Watson for Genomics can classify more than 10 million DNA changes linked to cancer. The data is gathered from a variety of sources, such as peer-reviewed publications, clinical studies, reputable databases, and partnerships with leading cancer institutes and diagnostic labs across the globe. Furthermore, Watson Health has collaborated with over 20 preeminent cancer centers to test and validate the technology. Through alliances with Quest Diagnostics and Illumina, the company is expanding access to precision medicine (IBM, 2018)

## GENOMICS



Source: IBM, 2024

The first university hospital in Europe to use IBM's artificial intelligence to assist physicians in choosing therapies for complicated cancer cases is the Hôpitaux Universitaires Genève in Switzerland. Rodolphe Meyer, who is responsible for the IT department of the Hôpitaux Universitaires Genève (HUG), pointed out that the software is designed to help doctors save time when determining which course of action is appropriate for a patient based on their genetic makeup, not to take the job of the clinicians. In order to determine a treatment that might be appropriate for each individual patient, physicians at the Swiss hospital frequently examine the DNA of cancer patients. Additionally, for a number of years, hospitals in Asia and North America have been using the program. IBM revealed earlier this year that 33% of patients at a South Korean hospital had actionable mutations found by Watson for Genomics that had not been found by manual screening (Labiotech, 2022).

- **Webiomed**

Webiomed became the first AI-based Russian software in healthcare officially registered as a medical device. The main focus of Webiomed is disease risk management, with chronic non-communicable diseases (NCDs), the leading cause of morbidity, in mind.

In Russia, a number of preventative measures against NCDs are in place, including annual medical examinations, the provision of a standardized set of surveys and inspection specialists, and the early detection of NCD risk factors. During screening, some issues worsen the final result: gathering and accounting for the completeness of medical data takes a long time, the accuracy of the risk assessment methods used is low, and their right interpretation might be challenging. Furthermore, medical appointments are frequently saturated, making it difficult to accurately understand complete and detailed medical information. As a result, the patient's risk stratification is not completed, and the relevant medical data is not used to avoid disease.

Usually, the health care system begins to deal with the patient only when the disease has already manifested itself, which often makes the prognosis heavier and requires higher treatment costs.

Webiomed, a Russian clinical decision support system (CDSS) is a predictive analytics and risk management software for patients. It is the product that will help to bring the effectiveness of disease prevention and diagnosis to a new level. The system is trained to analyze various medical data of the patient, identify risk factors and suspected cases of diseases, form forecasts based on them, containing a comprehensive assessment of the probability of developing various diseases and death of the patient from them. It offers personal recommendations for doctors and patients.

## DECISION SUPPORT SYSTEM



Source: Webiomed, 2024

Webiomed uses two models created by machine learning: one estimates the probability of developing cardiovascular diseases and the other, the individual probability of death from coronary heart disease and stroke.

## MACHINE LEARNING MODELS



Source: Webiomed, 2024

### Mayo Clinic Artificial Intelligence Model Forecasts Labor Risks

- **Mayo Clinic**

Mayo Clinic researchers created an AI-based risk prediction model that effectively informed pregnant women about labor risks and enhanced clinical decision-making. The model uses patient data acquired at the beginning of labor, such as baseline features, the patient's most recent clinical assessment, and cumulative labor progress since admission.

Why focus on this? Women in labor encounter numerous subjective and unexpected clinical risks, making it difficult for clinicians to predict the outcome of labor and delivery for both mother and child. To address this, researchers developed an AI-powered tool to forecast the clinical risks associated with vaginal birth.

In a study recently published, the AI developers described the model's ability to predict in real time whether someone in labor will experience a successful vaginal delivery with positive health outcomes for both the mother and baby, designed to potentially replace traditional labor charts, which can give a general idea of how labor is progressing but can fail to factor in all of the many variables that can affect the ultimate success of a delivery.

## MAYO CLINIC



Source: Mayo Clinic, 2024

### Implications of implementing AI on Preventive Health and Risk Assessment

- Early Health Risk Detection: AI's predictive analytics can spot possible health hazards early on, enabling prompt interventions and preventative actions.
- Customized Preventive advice: AI is capable of identifying specific risk variables and offering tailored preventive advice that support specific medical procedures.
- Giving People Knowledge About Their Health hazards: AI-driven risk assessments provide people with proactive health management and lifestyle changes by informing them about their health hazards.



# 07

# Ai

## Conclusions

Numerous important elements are the main drivers of artificial intelligence's rise in the healthcare industry. The importance of digital patient health data, which includes electronic medical histories, test results, and treatment plans, is becoming more and more important. Adoption of AI technologies is also fueled by the need to reduce healthcare costs and the growing demand for individualized therapy. Forecasts indicate that the healthcare AI market, estimated to be worth \$15.4 billion globally in 2022, would expand at a noteworthy annual rate of 37.5% between 2023 and 2030. The need for early disease identification and understanding is increasing as a result of factors like the growing older population worldwide, changing lifestyles, and an increase in chronic diseases.

AI is developing quickly in a number of healthcare fields and offers several benefits. Clinical Decision Support Systems, where AI evaluates complicated medical data to help experts make correct diagnosis and treatment plans, are important areas of study. In Diagnosis and Treatment Recommendations, AI algorithms are also used to evaluate medical pictures for accurate and timely disease identification. AI-powered solutions enhance patient engagement and adherence by providing individualized treatment and enhancing medication adherence via virtual health assistants. AI is being used to streamline administrative activities, improving productivity in areas like scheduling, billing, and electronic health record management. Furthermore, AI is essential to healthcare research since it speeds up the analysis of huge datasets. These developments have the power to completely transform healthcare by offering more individualized, effective, and efficient treatment.

Geographically speaking, North America is leading the way because of major contributions from companies like IBM, AWS, Google Health, and Flatiron Health. Siemens Healthineers, AstraZeneca, and DeepMind lead the way as Europe follows suit. Thanks to businesses like Alibaba Health Information Technology, NVIDIA, and Netgear, the Asia-Pacific area is growing quickly. Dr. Consulta and Hi Technologies in Brazil are two prominent South American companies offering AI-powered healthcare services. In the Middle East and Africa, artificial intelligence advances in breast cancer diagnosis and medical consultations are facilitated by Niramai Health Analytix in India and Vezeeta in Egypt, respectively.

North America leads the world market in revenue, making about 57.7% of the total sales. North America dominates the market due to a number of factors, including a strong healthcare IT infrastructure, rising healthcare costs, the extensive usage of AI and ML technologies, government initiatives, and the existence of significant industry participants. The second-largest area is Europe, which has significant contributions from important players in the life sciences industry. The fastest-growing market is found in the Asia-Pacific region, where advances in IT infrastructure, an emphasis on AI-based solutions by entrepreneurs, greater funding, and encouraging government activities are the main drivers.

AI integration in the healthcare sector has the potential to revolutionize the sector in a number of ways. The impact of AI on the healthcare industry is growing, and it is expected to be widely adopted in a variety of applications. The potential advantages extend throughout the whole healthcare value chain, from bettering patient management to increasing prognoses and diagnostics. Personalized treatment plans, medication discovery, medical picture generation, electronic health record enhancement, and many more applications highlight the significance of generative AI in particular. In addition to speeding up medication development, this revolutionary technique heralds the arrival of a new age in precision medicine, one that will provide individualized care for illnesses that were once thought to be incurable.

AI is predicted to transform healthcare as it gets increasingly integrated into the sector, changing not only how occupations are done but also the skills required, the workforce size, and overall processes. Adoption of AI is viewed as a chance to enhance human talents rather than to replace them, which could result in better patient care and higher job satisfaction. However, there is also recognition of the necessity for continued oversight and regulation, as well as worries about employment displacement and moral quandaries.

The effects on healthcare jobs are diverse. Although AI has the potential to improve diagnosis accuracy and expedite administrative tasks, there are worries that it may automate some jobs and hence leave some humans behind. It is anticipated that the nature of work itself will change, moving toward jobs requiring the development and management of AI systems. It is also expected that the use of AI will lead to new job opportunities, and as the effects of automation and AI are not fairly spread across professions, the industry will need to provide workers with the support they need.

Furthermore, it is anticipated that the advancement of AI will change the abilities required of healthcare workers. Technical abilities like software development, programming, and data analysis will become essential, as well as in-depth knowledge of AI technology. Healthcare workers will have to adjust to new competencies, such as continuous learning, flexibility, and patient privacy and data security. Collaboration between healthcare personnel and AI systems will be necessary for the integration of AI into healthcare, highlighting the need for experts who can direct AI toward its most advantageous applications.

The integration of AI is anticipated to have an impact on the number of workers in the healthcare industry. The workforce is likely to change as a result of new possibilities and responsibilities emerging, even while some occupations may be replaced. Beyond straightforward increases or decreases, the influence on employment will be more complex, with an emphasis on worker optimization through AI applications.

AI is expected to have a big impact on healthcare processes. It will provide advantages including tailored therapy, early disease identification, better diagnostic accuracy, and increased operational efficiency. It is anticipated that the use of AI would enhance patient outcomes, expedite processes, and support a proactive approach in healthcare.

Healthcare suppliers will also be able to benefit from AI, since it will enhance their supply chain management, procurement procedures, data-driven forecasting, and partnerships with healthcare providers. AI is predicted to bring about market disruptions, improve compliance and quality management, and open up new avenues for suppliers to become more competitive and better.

AI offers a wide range of advantages to clients in the healthcare industry, such as enhanced patient engagement, faster and more accurate diagnosis, better chronic condition management, easier access to care, streamlined tasks, and the detection and tracking of infectious diseases. It is projected that these advantages will result in better patient outcomes, higher life quality, and lower healthcare expenses.

The use of AI in healthcare carries some risks, even if there are a lot of potential benefits. When using synthetic patient data, privacy issues like as privacy breaches and regulatory blind spots present difficulties. Risks include the absence of a human touch in health treatment, ethical questions about informed consent and algorithmic fairness, and reliability challenges. Concerns about data security, such as breaches, invasions of privacy, and unauthorized access, emphasize the necessity of safety measures and legal guarantees. Concerns about job displacement are also recognized, especially with regard to regular chores and certain diagnostic procedures.

In conclusion, the application of AI in healthcare has the potential to completely transform the sector in a number of ways. From altering healthcare procedures and increasing patient outcomes to impacting employment, worker skills, and supplier relationships, AI is destined to usher in a new era. Although worries about ethical issues and job displacement still exist, general agreement highlights AI's potential to improve human capacities, transform the nature of work, and lead to improvements in healthcare care. To fully reap the benefits of AI integration, it will be imperative to adjust to new abilities, maintain oversight, and tackle ethical dilemmas as the healthcare sector changes.



# Tables

"Table 1. Competitor capabilities comparison"

"Table 2. Positives and negatives of AI developments"

"Table 3. Case studies"

# Bibliography

01. 3 factors driving AI surge in health care | AHA. (2023, March 14). American Hospital Association. <https://www.aha.org/aha-center-health-innovation-market-scan/2023-03-14-3-factors-driving-ai-surge-health-care>
02. A new vision for healthcare with AI | About Viz.ai. (2023, November 9). Viz.ai, The Proven AI-Powered Care Coordination Platform. <https://www.viz.ai/our-story>  
Admin. (2022, December 8). Impact of AI on the healthcare workforce. SynPlan. <https://www.synplan.ai/blog/impact-of-ai-on-the-healthcare-workforce>
04. AI and the Health Care Workforce | AHA. (n.d.). American Hospital Association. <https://www.aha.org/center/emerging-issues/market-insights/ai/ai-and-health-care-workforce>
05. AI in Healthcare: Beyond IBM Watson. (n.d.). TechTarget. <https://media.techtarget.com/digitalguide/images/Misc/EA-Marketing/Eguides/AI-in-Healthcare.pdf>
06. AI in Healthcare Market Size, Share & Trends Analysis Report by component (Software Solutions, Hardware, Services), by application (Virtual assistants, connected Machines), by region, and segment forecasts, 2024 - 2030. (2023a, November 22). <https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-healthcare->
07. AI is driving Google's health care business. Washington doesn't know what to do about it. (2023, December 4). POLITICO. <https://www.politico.com/news/2023/12/04/google-washington-ai-health-00129962>
08. AI to take center stage in healthcare in 2024. (2023, November 27). Healthcare Dive. <https://www.healthcaredive.com/spons/ai-to-take-center-stage-in-healthcare-in-2024/700098/>
09. AIMed. (2023, August 29). The impact of artificial intelligence on labor and employment in healthcare. <https://ai-med.io/more-news/the-impact-of-artificial-intelligence-on-labor-and-employment-in-healthcare/>
10. AllazoHealth. (2024a, January 10). Leverage AI to build a Best-In-Class patient support program. <https://allazohealth.com/resource-center/leverage-ai-to-build-a-best-in-class-patient-support-program/>
11. Analytics, E. I. (2023, September 27). AI-Powered Diagnostics: The future of early disease detection and Prevention. <https://www.linkedin.com/pulse/ai-powered-diagnostics-future-early/>
12. Artificial intelligence: 10 promising interventions for healthcare. (2023). [https://doi.org/10.3310/nihrevidence\\_59502](https://doi.org/10.3310/nihrevidence_59502)
13. Artificial Intelligence (AI) in Healthcare Market Size, share, Industry Report, Statistics and Growth Drivers 2032. (2024, February 8). MarketsandMarkets.
14. <https://www.marketsandmarkets.com/Market-Reports/artificial-intelligence-healthcare-market-54679303.html>  
Artificial Intelligence in Healthcare Market Size, Report 2022-2030. (n.d.). <https://www.precedenceresearch.com/artificial-intelligence-in-healthcare-market>

15. Artificial intelligence in the healthcare supply chain | Merck. (n.d.). <https://www.merckgroup.com/en/research/science-space/envisioning-tomorrow/precision-medicine/ai-in-supply-chain.html>
16. Asensus lines up digital surgery AI collaboration with Nvidia. (2023, September 8). Fierce Biotech. <https://www.fiercebiotech.com/medtech/asensus-lines-digital-surgery-ai-collaboration-nvidia>
17. Author, G. (2023, December 1). Bridging the gap achieving better healthcare outcomes through integrated systems. TechGig. <https://content.techgig.com/leaders-opinion/bridging-the-gap-achieving-better-healthcare-outcomes-through-integrated-systems/articleshow/105656367.cms>
18. Balagurunathan, Y., Mitchell, R., & Naqa, I. E. (2021). Requirements and reliability of AI in the medical context. *Physica Medica*, 83, 72–78. <https://doi.org/10.1016/j.ejmp.2021.02.024>
19. Banik, A., & Banik, A. (2021, December 29). Top 10 countries actively applying AI in healthcare. Health. <https://www.healthcareoutlook.net/top-10-countries-actively-applying-ai-in-healthcare/>
20. Bhor, A. (2023, January 27). Machine learning in healthcare: Use cases, Benefits & Challenges. Medium. <https://medium.com/@akashbhor111/machine-learning-in-healthcare-e84efcb196f9>
21. Bitkina, O. V., Park, J., & Kim, H. K. (2023). Application of artificial intelligence in medical technologies: A systematic review of main trends. *DIGITAL HEALTH*, 9. <https://doi.org/10.1177/20552076231189331>
22. Blog: Artificial Intelligence (AI) industry Trends in 2023: Market Size, Share & Forecast. (n.d.). Lab Lab. <https://lablab.ai/blog/ai-industry-trends-in-2023>
23. Bohr, A., & Memarzadeh, K. (2020a). The rise of artificial intelligence in healthcare applications. In Elsevier eBooks (pp. 25–60). <https://doi.org/10.1016/b978-0-12-818438-7.00002-2>
24. Bora, P. (2023, October 25). 27 Companies changing health outcomes through AI. Digital Authority Partners. <https://www.digitalauthority.me/resources/artificial-intelligence-in-healthcare/>
25. Botco.Ai. (2024, January 8). Top 10 use cases for generative AI in healthcare - botco.ai. Botco.ai. <https://botco.ai/top-10-use-cases-for-generative-ai-in-healthcare/>
26. Cancer researchers raise concerns about loss of ‘human touch’ with patient-facing AI. (2023, December 18). Healio. <https://www.healio.com/news/hematology-oncology/20231218/cancer-researchers-raise-concerns-about-loss-of-human-touch-with-patient-facing-ai>
27. Cardon, E. (2023, May 22). AI and Healthcare-Machine Learning Case Studies. <https://www.linkedin.com/pulse/ai-healthcare-machine-learning-case-studies-edward-cardon/>
28. Center, B. I. D. M. (2023, June 15). Researchers test AI-powered chatbot’s medical diagnostic ability. Newswise. <https://www.newswise.com/articles/researchers-test-ai-powered-chatbot-s-medical-diagnostic-ability>
29. Chorny, R. (2023a, August 8). 6 Benefits of AI in Healthcare & Hospitals. binariks. <https://binariks.com/blog/benefits-of-using-ai-in-healthcare/>

30. Bora, P. (2023, October 25). 27 Companies changing health outcomes through AI. Digital Authority Partners. <https://www.digitalauthority.me/resources/artificial-intelligence-in-healthcare/>
31. Botco.Ai. (2024, January 8). Top 10 use cases for generative AI in healthcare - botco.ai. Botco.ai. <https://botco.ai/top-10-use-cases-for-generative-ai-in-healthcare/>
32. Cancer researchers raise concerns about loss of ‘human touch’ with patient-facing AI. (2023, December 18). Healio. <https://www.healio.com/news/hematology-oncology/20231218/cancer-researchers-raise-concerns-about-loss-of-human-touch-with-patient-facing-ai>
33. Cardon, E. (2023, May 22). AI and Healthcare-Machine Learning Case Studies. <https://www.linkedin.com/pulse/ai-healthcare-machine-learning-case-studies-edward-cardon/>
34. Center, B. I. D. M. (2023, June 15). Researchers test AI-powered chatbot’s medical diagnostic ability. Newswise. <https://www.newswise.com/articles/researchers-test-ai-powered-chatbot-s-medical-diagnostic-ability>
35. Chorny, R. (2023a, August 8). 6 Benefits of AI in Healthcare & Hospitals. binariks. <https://binariks.com/blog/benefits-of-using-ai-in-healthcare/>
36. Chorny, R. (2023b, October 3). AI in The Healthcare Market Size: Statistics & Facts. binariks. <https://binariks.com/blog/artificial-intelligence-ai-healthcare-market/>
37. ClinicalTrials.gov. (n.d.). <https://clinicaltrials.gov/study/NCT01505478>  
CMR Surgical. (n.d.). CMR Surgical &#x2d; Transforming Surgery. For Good. <https://cmrsurgical.com/>
38. Daley, S. (2023, March 24). Artificial intelligence in Healthcare: 39 Examples Improving the future of medicine. Built In. <https://builtin.com/artificial-intelligence/artificial-intelligence-healthcare>
39. Dave, M., & Patel, N. (2023). Artificial intelligence in healthcare and education. *British Dental Journal*, 234(10), 761–764. <https://doi.org/10.1038/s41415-023-5845-2>
40. Davenport, T. H., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal*, 6(2), 94–98. <https://doi.org/10.7861/futurehosp.6-2-94>
41. Desai, D. (2023, April 17). Increasing patient engagement through the use of modern patient portals. <https://www.linkedin.com/pulse/increasing-patient-engagement-through-use-modern-portals-dhaval-desai>
42. Deveci, M. (2023). Effective use of artificial intelligence in healthcare supply chain resilience using fuzzy decision-making model. *Soft Computing*. <https://doi.org/10.1007/s00500-023-08906-2>
43. Dias, R., & Torkamani, A. (2019). Artificial intelligence in clinical and genomic diagnostics. *Genome Medicine*, 11(1). <https://doi.org/10.1186/s13073-019-0689-8>

44. Diaz, M. (2023, December 8). These are the jobs most likely to be taken over by AI. ZDNET. <https://www.zdnet.com/article/these-are-the-jobs-most-likely-to-be-taken-over-by-ai/>
45. Download citation of Global Evolution of Research in Artificial Intelligence in Health and Medicine: A Bibliometric Study. (n.d.).ResearchGate.[https://www.researchgate.net/publication/331639316\\_Global\\_Evolution\\_of\\_Research\\_in\\_Artificial\\_Intelligence\\_in\\_Health\\_and\\_Medicine\\_A\\_Bibliometric\\_Study/citation/download](https://www.researchgate.net/publication/331639316_Global_Evolution_of_Research_in_Artificial_Intelligence_in_Health_and_Medicine_A_Bibliometric_Study/citation/download)
46. Doximity GPT. (n.d.). <https://www.doximity.com/doximity-gpt-info>
47. Doximity rolls out beta version of ChatGPT tool for docs aiming to streamline administrative paperwork. (2023, February 11). Fierce Healthcare. <https://www.fiercehealthcare.com/health-tech/doximity-rolls-out-beta-version-chatgpt-tool-docs-aiming-to-streamline-administrative>
48. Driver, M. (2023, September 26). Medical Artificial Intelligence: 5 use cases for AI in Healthcare -. <https://thejournalofmhealth.com/medical-artificial-intelligence-5-use-cases-for-ai-in-healthcare/>
49. Education, I., & Education, I. (2023, October 3). The benefits of AI in healthcare. IBM Blog. <https://www.ibm.com/blog/the-benefits-of-ai-in-healthcare/>
50. Esan, T. (2023, August 29). The transformative impact of AI on medical and healthcare job roles. <https://www.linkedin.com/pulse/transformative-impact-ai-medical-healthcare-job-roles-tosin-esan>
51. Esmaeilzadeh, P., Mirzaei, T., & Dharanikota, S. (2021). Patients' Perceptions toward Human–Artificial Intelligence Interaction in Health Care: Experimental study. *Journal of Medical Internet Research*, 23(11), e25856. <https://doi.org/10.2196/25856>
52. Farhud, D. D., & Pourkalhor, H. (2024). Artificial intelligence in Genetics. *Cureus*. <https://doi.org/10.7759/cureus.52035>
53. Fernández, C. R. (2022, June 24). IBM's Watson for Genomics Launches in First European Hospital. *Labiotech.eu*. <https://www.labiotech.eu/trends-news/ibm-watson-genomics-european-hospital/>
54. Fortney, D. (2018, June 2). Healthcare innovation drivers: artificial intelligence and machine learning. *Medium*. <https://tincture.io/healthcare-innovation-drivers-artificial-intelligence-and-machine-learning-b543e67d4b2d>
55. Gerke, S., Minssen, T., & Cohen, G. (2020a). Ethical and legal challenges of artificial intelligence-driven healthcare. In Elsevier eBooks (pp. 295–336). <https://doi.org/10.1016/b978-0-12-818438-7.00012-5>
56. Gerke, S., Minssen, T., & Cohen, G. (2020b). Ethical and legal challenges of artificial intelligence-driven healthcare. In Elsevier eBooks (pp. 295–336). <https://doi.org/10.1016/b978-0-12-818438-7.00012-5>
57. Giuffrè, M., & Shung, D. (2023). Harnessing the power of synthetic data in healthcare: innovation, application, and privacy. *Npj Digital Medicine*, 6(1). <https://doi.org/10.1038/s41746-023-00927-3>
58. Gonzales, A., Guruswamy, G., & Smith, S. (2023). Synthetic data in health care: A narrative review. *PLOS Digital Health*, 2(1), e0000082. <https://doi.org/10.1371/journal.pdig.0000082>
59. Greggworth. (2023, September 27). Understanding the advantages and risks of AI usage in healthcare - Thomson Reuters Institute. Thomson Reuters Institute. <https://www.thomsonreuters.com/en-us/posts/technology/ai-usage-healthcare/>
60. Harris, M. (2021, June 24). First Surgical Robot from Secretive Startup Auris Cleared for Use. *IEEE Spectrum*. <https://spectrum.ieee.org/first-surgical-robot-from-secretive-startup-auris-cleared-for-use>
61. Hazarika, I. (2020). Artificial intelligence: opportunities and implications for the health workforce. *International Health*, 12(4), 241–245. <https://doi.org/10.1093/inthealth/ihaa007>
62. Hospital Pharmacy & Medication Management Software | Pharmacy Workflow Solutions | Pharmacy Data Analytics. (2023, October 18). *Vigilanz*. <https://vigilanz.com/clinical-surveillance/pharmacy-surveillance/>

63. How Alibaba is using artificial intelligence in healthcare. (2017, July 13). Nasdaq. <https://www.nasdaq.com/articles/how-alibaba-using-artificial-intelligence-healthcare-2017-07-13>
64. How can AI detect diseases earlier? (2023, August 10). www.linkedin.com. <https://www.linkedin.com/advice/0/how-can-ai-detect-diseases-earlier-skills-artificial-intelligence%C2%BFc%C3%B3mo-puede-la-ia-detectar-enfermedades-antes>
65. How can you prepare for AI integration in healthcare? (2023, August 20). www.linkedin.com. <https://www.linkedin.com/advice/0/how-can-you-prepare-ai-integration-healthcare>
66. How experts see AI changing healthcare supply chains. (2023, October 23). Healthcare Dive. <https://www.healthcaredive.com/spons/how-experts-see-ai-changing-healthcare-supply-chains/697044/>
67. How is AI reshaping health research | News | Wellcome. (2023, November 1). Wellcome. <https://wellcome.org/news/how-ai-reshaping-health-research>
68. Intech\_Wtc, & Intech\_Wtc. (2021, October 27). Sense.ly: Conversational AI connecting patients and healthcare companies | Intech.media. [intech.media. https://intech.media/en/medicaltech/sense-ly-conversational-ai-connecting-patients-and-healthcare-companies/](https://intech.media/en/medicaltech/sense-ly-conversational-ai-connecting-patients-and-healthcare-companies/)
69. InvestGlass. (2023, February 20). ¿Qué países lideran la carrera de la inteligencia artificial? InvestGlass. <https://www.investglass.com/es/which-countries-are-leading-the-ai-race/>
70. Jangid, S. (2024, February 8). Explore the use cases of generative AI across top industries. Tech Blog | Mobile App, eCommerce, Salesforce Insights. <https://www.emizentech.com/blog/use-cases-of-generative-ai.html>
71. Jorie AI | Empowering Telehealth: The role of AI for Remote Patient Care. (n.d.). [https://www.jorie.ai/post/empowering-telehealth-the-role-of-ai-for-remote-patient-care#:~:text=AI&apos;s%20Role%20in%20Remote%20Patient%20Care&text=Enhanced%20Remote%20Monitoring%20Through%20wearables,patients%20with%20chronic%20diseases%20effectively.](https://www.jorie.ai/post/empowering-telehealth-the-role-of-ai-for-remote-patient-care#:~:text=AI%20Role%20in%20Remote%20Patient%20Care&text=Enhanced%20Remote%20Monitoring%20Through%20wearables,patients%20with%20chronic%20diseases%20effectively.)
72. Kevin. (2023, March 11). Why human touch matters in health care: the limitations of AI. KevinMD.com. <https://www.kevinmd.com/2023/02/why-human-touch-matters-in-health-care-the-limitations-of-ai.html>
73. Kumar, A., Mani, V., Jain, V., Gupta, H., & Venkatesh, V. (2023a). Managing healthcare supply chain through artificial intelligence (AI): A study of critical success factors. Computers & Industrial Engineering, 175, 108815. <https://doi.org/10.1016/j.cie.2022.108815>
74. Kumar, A., Mani, V., Jain, V., Gupta, H., & Venkatesh, V. (2023b). Managing healthcare supply chain through artificial intelligence (AI): A study of critical success factors. Computers & Industrial Engineering, 175, 108815. <https://doi.org/10.1016/j.cie.2022.108815>
75. Learn about Sensely's suite of conversational AI solutions - Sensely. (2022, October 13). Sensely. <https://sensely.com/solutions/>
76. LifeSciencesIntelligence. (2023, November 17). Embracing AI in Life Sciences: Opportunities for healthcare technology. LifeSciencesIntelligence. <https://lifesciencesintelligence.com/features/embracing-ai-in-life-sciences-opportunities-for-healthcare-technology>

77. Limited, I. (n.d.). Electronic Health Record case Study | Infosys. <https://www.infosys.com/industries/healthcare/case-studies/electronic-health-records.html>
78. Loria, K. (2023, October 2). Utilizing AI for medication management. Drug Topics. <https://www.drugtopics.com/view/utilizing-ai-for-medication-management>
79. Lprokhorova. (2020, May 1). AI-based medical system registered in Russia. Investforesight. <https://investforesight.com/ai-based-medical-system-registered-in-russia/>
80. Lucas, J., & Badaracco, C. (2023, December 9). AI in Healthcare: 5 Areas in Which Artificial Intelligence Is Disrupting the Status Quo. Avalere. <https://avalere.com/insights/ai-in-healthcare-5-areas-in-which-artificial-intelligence-is-disrupting-the-status-quo>
81. M, A. A. (2023, June 9). Countries leading the way in AI - Xaltius. Xaltius. <https://xaltius.tech/countries-leading-the-way-in-ai/>
82. Mānoa: AI can predict cancer risk through mammograms | University of Hawaii News. (n.d.). <https://manoa.hawaii.edu/news/article.php?ald=11568>
83. Masercola, E. (2023, September 25). AI jobs in healthcare. Healthcare IT Leaders. <https://www.healthcareitleaders.com/blog/ai-jobs-in-healthcare/>
84. Mayo Clinic AI could predict labor outcomes in real time: study. (2022, September 2). Fierce Biotech. <https://www.fiercebiotech.com/medtech/mayo-clinic-ai-could-predict-labor-outcomes-real-time-study>
85. McKeon, J. (2021, December 1). Security, Privacy Risks of artificial intelligence in healthcare. HealthITSecurity. <https://healthitsecurity.com/features/security-privacy-risks-of-artificial-intelligence-in-healthcare>
86. Medical Device Network. (2022, September 18). ECential Robotics' Spine Surgery Platform, France. <https://www.medicaldevice-network.com/projects/encial-robotics-spine-surgery-france/?cf-view>
87. Melchionna, M. (2022, September 1). New Mayo Clinic artificial intelligence model provides labor risk predictions. HealthITAnalytics. <https://healthitanalytics.com/news/new-mayo-clinic-artificial-intelligence-model-provides-labor-risk-predictions>
88. Moore, J. (2023, March 14). AI in health care: the risks and benefits. MedicalEconomics. <https://www.medicaleconomics.com/view/ai-in-health-care-the-risks-and-benefits>
- Naik, N., Hameed, B. M. Z., Shetty, D. K., Swain, D., Shah, M., Paul, R., Aggarwal, K., Ibrahim, S., Patil, V., Smriti, K., Shetty, S., Prasad, B., Chłosta, P., & Somani, B. (2022). Legal and ethical consideration in artificial intelligence in healthcare: Who takes responsibility? *Frontiers in Surgery*, 9. <https://doi.org/10.3389/fsurg.2022.862322>
89. News-Medical. (2023, November 8). AI-Powered Genomic Analysis: Revolutionizing the detection of genetic mutations. <https://www.news-medical.net/health/AI-Powered-Genomic-Analysis-Revolutionizing-the-Detection-of-Genetic-Mutations.aspx#:~:text=The%20power%20of%20AI%20in%20genomics%20analysis,-Artificial%20intelligence%20plays&text=These%20algorithms%20can%20identify%20patterns,mutations%20and%20their%20potential%20effects.>
90. NIRAMAI Health Analytix Case Study | Google Cloud. (n.d.). Google Cloud. <https://cloud.google.com/customers/niramai>  
Patient Engagement | Cerner. (n.d.). <https://www.cerner.com/ca/en/solutions/patient-engagement>

91. Pelta, R. (2023, December 1). What jobs will AI replace and what can you do about it? Forage. <https://www.theforage.com/blog/careers/what-jobs-will-ai-replace>
92. PricewaterhouseCoopers. (n.d.). No longer science fiction, AI and robotics are transforming healthcare. PwC. <https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html>
93. Pros & Cons of Artificial intelligence in Medicine - College of Computing & Informatics. (2021, July 21). College of Computing & Informatics. <https://drexel.edu/cci/stories/artificial-intelligence-in-medicine-pros-and-cons/>
94. Rajaratnam, V. (2023, September 3). The future of healthcare workers in the age of artificial intelligence and generative AI. <https://www.linkedin.com/pulse/future-healthcare-workers-age-artificial-intelligence-rajaratnam/>
95. Risks and remedies for artificial intelligence in health care | Brookings. (2022, March 9). Brookings. <https://www.brookings.edu/articles/risks-and-remedies-for-artificial-intelligence-in-health-care/>
96. Robotics, E. (2024, January 8). eCential Robotics: open surgical robotic platform. eCential Robotics. <https://www.ecential-robotics.com/en-gb>
97. Sensely. (n.d.). Sensely | LinkedIn. <https://www.linkedin.com/company/sense-ly/>
98. Sinha, S. (2023, September 22). The role of artificial intelligence in enhancing patient centricity in pharmacology. <https://www.linkedin.com/pulse/role-artificial-intelligence-enhancing-patient-centricity-sinha>
99. Soft Skills for Healthcare. (2023, October 14). Implementing AI without losing the 'Human touch' in healthcare. <https://esoftskills.com/healthcare/implementing-ai-without-losing-the-human-touch-in-healthcare/>
100. Staff, K. (2023, December 15). The impact of AI on healthcare: Remote patient monitoring. KMS Healthcare. <https://kms-healthcare.com/the-impact-of-ai-on-healthcare-a-deep-dive-into-remote-patient-monitoring/>
101. Staff, R. 2. (2022, May 3). Auris Health Surgical Robot System Receives FDA 510(k) Clearance for Urological Procedures. Robotics 24/7. [https://www.robotics247.com/article/auris\\_health\\_surgical\\_robot\\_system\\_receives\\_fda\\_510k\\_clearance\\_for\\_urological\\_procedures](https://www.robotics247.com/article/auris_health_surgical_robot_system_receives_fda_510k_clearance_for_urological_procedures)
102. Surgical, C. (2023, February 9). VR training for surgical robot Versius &#x2d; CMR Surgical. CMR Surgical. <https://cmrsurgical.com/news/versius-virtual-reality>
103. Takyar, A. (2024, January 23). AI in Healthcare: Innovative use cases and applications. LeewayHertz - AI Development Company. <https://www.leewayhertz.com/ai-use-cases-in-healthcare/>
104. Talby, D. (2023, May 26). The dangers of using synthetic patient data to build healthcare AI models. Forbes. <https://www.forbes.com/sites/forbestechcouncil/2023/05/26/the-dangers-of-using-synthetic-patient-data-to-build-healthcare-ai-models/?sh=794bf4c770da>
105. Telefónica. (2023, March 2). What are the benefits of Intelligence Artificial in the medicine? Telefónica. <https://www.telefonica.com/en/communication-room/blog/what-are-the-benefits-of-intelligence-artificial-in-the-medicine/>



106. Thaler, S. (2023, November 30). These are the jobs most likely to be taken over by AI: report. New York Post. <https://nypost.com/2023/11/30/business/these-are-the-jobs-most-likely-to-be-taken-over-by-ai-report/>  
The Health Foundation. (n.d.). What do technology and AI mean for the future of work in health care? - The Health Foundation. <https://www.health.org.uk/publications/long-reads/what-do-technology-and-ai-mean-for-the-future-of-work-in-health-care>
107. Transforming healthcare with AI: The impact on the workforce and organizations. (2020, March 10). McKinsey & Company. <https://www.mckinsey.com/industries/healthcare/our-insights/transforming-healthcare-with-ai>
108. Vezeeta's ePharmacy Solution Makes Access to Prescription Medications in Egypt Easier than Ever. (2021, February 3). EgyptToday. <https://www.egypttoday.com/Article/6/97167/Vezeeta%E2%80%99s-ePharmacy-Solution-Makes-Access-to-Prescription-Medications-in-Egypt>
109. Webiomed became the first AI-based Russian software in healthcare officially registered as a medical device. (n.d.). Webiomed. <https://webiomed.ai/en/news/webiomed-system-first-registered-russian-software-as-medical-device/>
110. Why is AI adoption in health care lagging? | Brookings. (2022, March 9). Brookings. <https://www.brookings.edu/articles/why-is-ai-adoption-in-health-care-lagging/>
111. World Health Organization: WHO. (2023, May 16). WHO calls for safe and ethical AI for health. World Health Organization. <https://www.who.int/news/item/16-05-2023-who-calls-for-safe-and-ethical-ai-for-health>
112. Xsolis. (2023, December 14). 3 Case studies of successful implementations of AI in healthcare - XSolis. Xsolis. <https://www.xsolis.com/blog/case-studies-of-successful-implementations-of-ai-in-healthcare/>
113. Zinkula, J., & Mok, A. (2024, January 15). ChatGPT may be coming for our jobs. Here are the 10 roles that AI is most likely to replace. Business Insider. <https://www.businessinsider.com/chatgpt-jobs-at-risk-replacement-artificial-intelligence-ai-labor-trends-2023-02>



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